Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; SP2: 693-698

Kathiravan Muthuselvan
Directrate of Seed Centre, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Marimuthu Subbaiyan
National Pulses Research Centre, Vamban, Pudukkottai, Tamil Nadu, India

Correspondence
Kathiravan Muthuselvan
Directrate of Seed Centre, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Organic seed priming and foliar nutrition with medicinal herbs to enhance seedling vigour and yield potential in maize (*Zea mays* L.)

Kathiravan Muthuselvan and Marimuthu Subbaiyan

Abstract
Experiment was conducted during 2013 at Agricultural Research station, Vaigaidam to identify the effect of organic priming and foliar nutrition with herbal leaf extracts of chicory (*Cichorium indybus* L.), clerodendron (*Clerodendran inerme* L.), noni (*Morinda tinctoria* L.) and calotropis (*Calotropis procera* L.) on seedling vigour and productivity potential in maize. Maize seeds were soaked in fresh leaf extracts of *Cichorium indybus* L.), (5, 10 and 15 %), *Morinda tinctoria*, *Clerodendran inerme* and *Calotropis procera* (1, 2 and 3 %) in double the volume of herbal extract for 12 h. Seeds soaked in water (12 h) formed the control. Maize seed priming with 1 % leaf extract of *Morinda tinctoria*, significantly increased the germination (94 %), rate of germination (16.26) and dry matter production (2.74 g) compared to control. The electrical conductivity (0.190 dSm^{-1}), leachate amino acids (27.52 µg), sugars (30.72 µg) and lipid peroxidation (0.110 µg) were minimum in leaf 1% extract of *Morinda tinctoria* but the dehydrogenase, catalase and peroxidase enzyme activity were higher (0.357, 2356 units and 0.390 mg, respectively). Combined effect of seed priming with 1% leaf extract of *Morinda tinctoria* and foliar nutrition spray with noni (2% extract) at 40 and 60 Days After Sowing increased the plant height in both *kharif* and *rabi* seasons (207 cm and 212 cm), maximum plant dryweight (266 g and 273 g), more leaf area index (11.10 and 12.03), higher crop growth rate (38.25 g and 40.80 g) and relative growth rate (25.20 mg and 26.12 mg).Tassel initiation was early (47 days and 46 days) and produced lengthier cobs (20.75 cm and 21.60 cm), more number of seeds (507 and 523), higher yield (6655 kg/ha and 6710 kg/ha) with maximum 100 seed weight (28.93 g and 28.93 g). The present study revealed that subjecting the maize to 12 h seed priming in 1 % leaf extract and foliar nutrition with 2% leaf extract of *Morinda tinctoria* at 40 and 60 Days after Sowing increased the seedling vigour and yield attributing factors in maize.

Keywords: maize, medicinal herbs, leaf extract, organic priming, foliar nutrition, seedling vigour and yield

Introduction
Maize (*Zea mays* L.) is one of the important cereal crops. The increase in yield achieved in this crop is far from satisfactory despite the attempts made through genetic improvement towards higher harvest index, response to management practices and related factors. Of the several reasons attributed to poor performance, seed quality is considered to be very important. If the seed is less vigorous and produces small slow growing seedling, those plants could never compensate for the low vigour and yield as much as is possible from a vigorous seed (Brabani 2011) [5]. A good seed treatment should therefore, aim at infusing quality in the seed lot, to produce an autotrophic seedling in the field at the earliest, so as to realize the full potential of the seed. Simple hydration- dehydration (Suneetha *et al.*, 2003) [21] and vapours (Mandal *et al.*, 2000) [16] have been reported to augment seed quality. It seems that most of the seed treatments aim only at maintenance of vigour and viability and research attempts on understanding the effect of vigour on productivity are scanty.
Commonly medicinal plants are used widely in traditional systems and fully restricted to human and animal health care; no attempt has been made for exploitation in agriculture, particularly for seed treatment and foliar spray. In the present study, the extracts of medicinal plants such as *Cichorium indybus* L., *Clerodendran inerme* L. *Morinda tinctoria* L. and *Calotropis procera* L were used for seed priming and foliar spray experiments so as to elucidate their effect on seed germination, seedling vigour and crop productivity of maize.

Materials and Methods
Maize seeds cv. CO l was collected from Maize Research Station, Vagarai, Tamil Nadu and dried to uniform moisture content in a drying cabinet at 30 $\pm$ 1^0C for four days (approx. 11 $\pm$

0.5 %) and used for this study. Medicinal herbs *viz*., chicory (*Cichorium indybus* L.), clerodendron (*Clerodendran inerme* L.), noni (*Morinda tinctoria* L.) and calotropis (*Calotropis procera* L.) were obtained from Depatment of Medicinal and Aromatic Plants, Horticultural College and Research Institute, Periyakulam, Tamil Nadu.

Experiment I: Effect of Organic priming of seeds with herbal extracts on seed germination and seedling vigour

Fresh leaves (100 g) of the medicinal plants were collected from 45 days old plants of chicory, clerodendron, noni and calotropis. The leaves were macerated in a mortar and pestle using 100 ml of water to attain 100 per cent leaf extract. Uniform sized seeds of maize cv. CO1 (retained by 20/64" round perforated metal sieve) were soaked in fresh chicory leaf extract @5, 10 and 15 % and, noni, clerodendran, calotropis leaf extract @1, 2 and 3 % by taking double the volume of the extract solutions for 12 h. Seeds soaked in water served as control. The primed seeds were dried under shade and then in a drying chamber maintained at 30 $\pm$ 0.5^{0}C to reach the original moisture content (11 $\pm$ 0.5%). Immediately after treatment germination test was carried out in paper medium in quadruplicate using 100 seeds for each treatment with four sub replicates of 25 seeds following inclined plate method in a germination room maintained at a temperature of 25 ± 1°C and RH 96 ± 2 % with diffused light (approx. 10 h) during the day. Final count on normal seedlings was recorded on seventh day and percent germination computed. Rate of germination was calculated using the formula of Maguire, (1962) [14].

$$\text{Rate of germination} = \frac{X_1}{Y_1} + \frac{X_2 - X_1}{Y_2} + \ldots + \frac{X_n - (X_n - 1)}{Y_n}$$

Where, X_n = Percentage germination on n^{th} count

Y_n = Number of days from sowing to n^{th} count

The seedling dry weight was determined using normal seedlings after drying at 80°C for 36 h. The dehydrogenase enzyme activity (Kittock and Law, 1968) [11], electrical conductivity, amino acids, catalase activity (Luck, 1974) [13] and lipid peroxide formation (Bernheim *et al*., 1948) [4] were assessed.

Experiment II: Effect of foliar spray with herbal extracts on crop growth and productivity

To screen the optimum concentration of herbal leaf extract for foliar spray, an experiment was conducted during 2012-13 at Agricultural Research station, Vaigaidam (10° 0' North and 77° 8' East and altitude of 242 M above MSL). The soil texture of the experimental field is deep ulfisol, pH and EC is 7.2 and 0.32 dSm^{-1}, respectively. Field trial was conducted by adopting Randomized Block Design (RBD) with three replications. Seed rate compensation was done to maintain the plant population per unit area (Manjunathaswamy and Narayanaswamy, 1996) [17]. Foliar spray with medicinal leaf extracts *viz*., chicory (*Cichorium indybus* L.) leaf extract (5 and 10 per cent), noni (*Morinda tinctoria* L.), clerodendran (*Clerodendran inerme* L.), calotropis (*Calotropis procera* L.) leaf extract (1 and 2 per cent) along with Di Ammonium Phosphate (DAP) 2% for comparison (Already recommended) were given at two growth stages *i.e.*, 40 and 60 Days After Sowing (DAS).

Experiment III: Combined effect of seed priming and foliar spray with herbal extracts on seed germination, plant growth and crop productivity

Maize seeds were subjected to seed priming with 1% extract of noni (*Morinda tinctoria* L.) as standardized in Experiment I by adopting Randomized Block Design (RBD) with three replications. The primed seeds were sown in the experimental field during *kharif* season (June-September 2012). Foliar spray treatment were imposed with best concentrations as in Experiment II *viz.*, chicory 5%, noni 2%, clerodendran 2% and calotropis 2% herbal extracts at 40 and 60 DAS. The confirmatory trial was conducted was with the same set of treatments during the *rabi* season (October-January 2012-13). In both seasons, observations were made on plant growth and yield parameters. Dry weight of the plants was recorded at 60 days after sowing. Leaf area index after 60 days of sowing and net assimilation rate between 60-90 days of sowing were determined. Yield parameters viz., tassel initiation (days), cob initiation (days), days to 50% flowering; length and girth of cob (cm), number of seeds per cob were observed. Seed yield (kg/ha) and 100 seed weight (g) were recorded after drying to uniform moisture content (9 ± 0.25%). The data were subjected to an Analysis of Variance and treatment differences tested (test) for significance ($P \geq 0.05$) (Gomez and Gomez, 1984). Wherever necessary, the percentage values were transformed to arc sine values prior to statistical analysis.

Results and Discussion

Experiment I

The results obtained in the experiment on seed priming with herbal extracts revealed that there was highly significant difference among the different treatments in maize seed germination as well as seedling vigour. Seed priming with noni 1% and chicory 10% leaf extract recorded the highest germination of 94 % and 90 % respectively, which were 22 % and 20 % higher than control (72 %). Similarly, significant difference was also observed among the treatments in rate of germination. The highest rate of germination was recorded in noni 1% leaf extract (16.26 seedlings/day). Root length of the seedling was found to be highest in seeds primed with 1% extract of noni leaf (23.87 cm) and this was closely followed by 10% chicory leaf extract (22.70 cm). Shoot length also found to be highest in noni leaf 1% extract (26.70 cm). Maize seeds primed with noni leaf 1% extract produced highest dry weight (2.74 g) which was significantly superior to control (1.92 g). All the seed priming treatments with herbal leaf extracts were found to be effective in improving the seed germination and seedling vigour, irrespective of the concentrations.

Electrical conductivity of seeds subjected to seed priming with herbal leaf extracts was measured inorder to assess the membrane integrity of the seeds. The observations revealed that electrical conductivity of the seeds subjected to different seed priming treatments differed significantly. The lowest values were recorded in seeds primed with noni leaf 1% extract (0.190 dSm^{-1}), while the hydroprimed seeds (0.212 dSm^{-1}) and control (0.226 dSm^{-1}) recorded higher values (Table 1). The leachate amino acids, sugars and lipid peroxidation were minimal in seeds primed with noni leaf 1% extract (27.52 µg, 30.72 µg and 0.110 µg, respectively) compared to control which recorded 37.84 µg, 46.54 µg and 0.146 µg, respectively. (Table 2). The dehydrogenase enzyme activity was significantly higher in seeds primed with noni

1% leaf extract (0.357) followed by chicory 10% (0.348), while unprimed control seeds (0.267) recorded the lowest values. Besides, dehydrogenase activity, catalase activity and peroxidase activity was also found to be highest in seeds primed with noni leaf 1% extract. The catalase activity recorded with noni leaf 1% extract was found to be to the level of 2356 units/g and this was at par with 10% chicory leaf extract (2243 units/g). The highest level of peroxidase activity was also registered in maize seeds primed with noni 1% leaf extract (0.390 mg), while the control seeds recorded lowest value of 0.230 mg only (Table 2).

Lipid peroxidation is a chain of free radicle reactions that leads to membrane damage and loss of activity in the associated organelles such as mitochondria, endoplasmic reticulum, ribosomes, etc., (Beckman and Ames, 1997) [3]. In the present study, the level of lipid peroxidation has been found to be very low in seeds primed with 1% noni leaf extract. It is clear that highly reactive free radical groups are produced in dry seeds and they have the potential to do induce considerable peroxidative changes in both cell membrane and nucleic acids (Kibinza *et al*., 2006) [10]. In the present investigation, the lipid peroxidation was maximum in untreated control which is attributed to the lipid peroxidation and free radical reactions that are basic causes of deteriorative senescence (Balesevic *et al*., 2005) [2]. It is possible that biochemical properties *viz*., phenolic compounds, organic acids, proteins and alkaloids (Senthilkumar, *et al*., 2016) [20] present in noni extracts would have helped for substitution of scavenging properties to bring down peroxidative changes ultimately maintaining vigour and viability at a higher level. Many results on the antioxidative activity of noni have been reported (Yang *et al*., 2007; Jeffers *et al*., 2007) [25, 9]. The total phenolic content from noni fruit extract showed a best total antioxidant activity (4.018 to 4.001 mg/g) which may counteract the free radicals (Thirukkumar *et al*., 2017) [23]. *Morinda citrifolia* L. leaves contain a variety of phytochemical constituents, including terpenoids, phytosterols, fatty acids and their glycosides (Takashima *et al*., 2007) [22]. The lower level of lipid peroxidation might have also been a consequence of higher level of antioxidant enzymes such as catalase and peroxidase recorded in these maize seeds primed with 1% noni leaf extract (Guan and Scandalios, 2002) [8]. The measure of electrical conductivity, leachate amino acids and sugars are indicators of membrane integrity of the seeds (Yasmeen *et al.*, 2013) [26]. The data obtained for all the three parameters have established that membrane integrity of the maize seeds subjected to seed priming with 1% noni leaf extract has been largely regained. Besides, the lipid peroxidation levels recorded by the above priming treatment have also been found to be very low compared to other priming treatments as well as control. These factors indicate the improved metabolic capacity of these seeds, which is also observed in the higher level of enzyme activities recorded by these seeds. Dehydrogenase enzyme is the only enzyme which is directly associated with the resipiration potential and viability status of the seeds. In the present study, higher level of dehydrogenase has been recorded in the maize seeds subjected to seed priming with 1% noni leaf extract. The data indicates that mitochondrial repair and reconstitution has occurred in a higher level in these seeds leading to the higher level of dehydrogenase activity and eventually higher viability potential of these seeds. Priming treatment enhances the repair of damage to vital organelles and counteraction of lipid peroxidation and minimization of free radical reaction (McDonald, 1999) [18]. The higher level of seed germination percentage and speed of germination observed in the present study in the seeds subjected to seed priming with 1% noni leaf extract is attributable to the higher level of dehydrogenase activity in these seeds and it is in conformity with the results of Anitha *et al*., (2013) [1] and Kumar *et al*., (2017) [12].

Experiment II

In the field experiment conducted to study the relative effectiveness of four different herbs when applied over the crop as foliar spray, the data revealed that herbal leaf extract spray had significantly improved the maize plant growth and yield parameters. Among the treatments, 2% leaf extract of noni leaf significantly increased the plant height (196 cm) and recorded highest plant dry weight (257 g/plant) compared to control (170 cm and 164 g/plant, respectively) (Fig. 1). The same treatment also induced earlier tassel formation (47 DAS), 50 % flowering period (51 DAS) and cob initiation (52 DAS), while the control plants recorded a delayed crop growth by registering tassel formation, 50 % flowering and cob initiation on 55, 62 and 59 DAS (Days After Sowing), respectively (Fig.1). The foliar spray with noni leaf 2% extract had also recorded significantly higher values for number of seeds per cob (510), seed yield (6520 kg/ha) and 100 seed weight (29.03 g) than control (351, 5590 kg/ha and 27.41 g, respectively) (Table S1.).

Experiment III

In order to study and confirm the combined effect of seed priming and foliar spray with noni extract on seed germination, plant growth and crop productivity of maize the field trials were conducted during *kharif* 2012 (June – September) and *rabi* 2012-13 (October-January). In the present trial the maize seeds were subjected to seed priming with 1% leaf extract of noni and sown in the field along with control. The crop raised were subjected to foliar spary as decribed earlier. The results obtained with respect to crop growth parameters revealed that, seeds primed with noni leaf (1% extract) and subjected to foliar spray with 2% extract of noni leaf had recorded significantly higher values for plant growth in both the seasons *viz.*, *kharif* (June –September) and *rabi* (October-January) compared to control. In corroboration with the highest plant height recorded by plants sprayed with noni 2% extract *viz.*, 173 cm and 182 cm, in *kharif* and *rabi*, respectively, the same treatment also recorded higher plant dry weight of 266 g plant^{-1} in *kharif* and 273 g plant^{-1} in *rabi.* Pooled analysis clearly brought out the better performance of seeds primed with noni leaf 1% extract and foliar spray with noni leaf 2% extract (270 g/ plant) over control (164 g /plant). Maize crop responded well to the seed priming and foliar treatment with noni leaf extracts by registering higher leaf area index in both seasons (11.10 and 12.03, respectively) over control (7.65 and 8.05) (Fig.2). The Crop Growth Rate (CGR) was also maximum when maize was subjected to seed priming with noni leaf 1% extract and foliar spray with non leaf 2% extract (39.53 g). The other herbal extracts were also found to effective in improving the crop performance compared to control but to a lesser magnitude (Fig. 2). The Relative Growth Rate (RGR) of plants reflected a similar trend as that of CGR. The superiority of seed priming 1% noni leaf extract and foliar nutrition with 2% noni leaf extract was evident in both the seasons, since it recorded 38 per cent increase over control in both *karif* and *rabi*, respectively (Table S3). In both the seasons, the net assimilation rate was

also significantly higher in the same treatment (0.47 mg and 0.51 mg) than control (0.36 mg and 0.37 mg). Tassel initiation occured earlier in plants subjected to priming (noni 1% extract) and foliar nutrition (noni 2% extract) in both *kharif* (47 DAS) and *rabi* (46 DAS), while the control plants needed 56 DAS and 55 DAS for tassel initiation, in kharif and rabi, respectively. Pooled analysis indicated that seeds primed with 1 % noni leaf extract and foliar spray with 2 % noni leaf extract reached flowering stage earlier (52 days) than the control (60 days) (Table S4). The same treatment also showed earlier cob formation (51.5 days) than control (58 days) which ultimately resulted in longer cobs, in both seasons. Regarding cob length, pooled analysis revealed that seeds primed with 1 % and foliar spray with 2 % noni leaf extract produced cobs of 21.2 cm length but control produced only shorter cobs (16.1 cm) (Table 4). In both *kharif* (June-September 2012) and *rabi* (October-January 2012-13) seasons, the same treatment recorded higher values for cob girth (13.0 cm and 13.12 cm) (Fig.3). The cumulative effect of higher length and girth of cobs was observed in the higher number of seeds cob^{-1}. Pooled analysis revealed that for all the herbal treatments number of seeds per cob had an edge over control and the effect was more pronounced in noni leaf extract priming (1%) and 2% foliar spray (515) (Fig.3). In both the seasons, herbal leaf extract priming and foliar spray responded well for yield increase compared to control. Pooled mean proved that 100 seed weight was maximum in seeds primed with 1% and foliar spray with 2% noni leaf extract (28.90g) than control (27.47g) and also recorded higher seed yield of 6683 kg/ha compared to control which recorded 5597 kg/ha.

The super imposition of foliar spray with noni 2% extract on the plants grown from maize seeds primed with 1% noni leaf extract revealed significantly superior plant growth and crop productivity attributes. This might be due to enhanced level of nutrients available in the rhizo-ecosystem of the foliar applied nutrients resulting in better plant growth and development In order to achieve the highest possible yield, the physiological parameters especially leaf area index must be higher to intercept more solar energy for higher dry matter accumulation (Major and Daynard, 1972) [15]. Crop growth rate, relative growth rate and net assimilation rate as a measure of growth efficiency were highest in priming and foliar nutrition with noni leaf extract and gain support from the work of Anitha *et al.*, 2013 [1] and Patil *et al*., 2012 [19] in chickpea. The reproductive output and dry matter accumulation are positively correlated (Carlos *et al.*, 1995) [6] and in the present study the difference in dry matter accumulation was wider between primed cum foliar treatments and control seeds. It is inferred that higher values for plant growth, physiological parameters and yield in noni leaf extract treatment could explain by providing additional nutrients to the plants and efficient translocation of assimilates to the sink.

The finding proved that combination of seed priming with 1% and foliar spray with 2% noni leaf extract (*Morinda tinctoria* L.) at 40 and 60 days after sowing enhanced the seedling vigour and increased the plant growth parameters and yield in maize.

Table 1: Effect of seed priming with herbal leaf extract on seed quality characteristics in maize

Treatments	Germination (%)	Rate of germination (Seedlings /day)	Root length (cm)	Shoot length (cm)	Dry matter production (g seedlings $^{-10}$)	Electrical conductivity (dSm^{-1})
Control	72 (60.73)	11.57	17.20	18.51	1.92	0.226
Water	78 (61.45)	13.46	19.04	20.64	2.20	0.212
Chicory 5 %	82 (63.40)	14.70	21.30	23.56	2.46	0.210
Chicory 10 %	90 (66.87)	15.90	22.70	25.71	2.67	0.192
Chicory 15 %	87 (65.11)	15.15	22.14	24.16	2.54	0.205
Noni 1%	94 (68.23)	16.26	23.87	26.70	2.74	0.190
Noni 2 %	88 (65.76)	15.75	23.14	25.13	2.60	0.195
Noni 3%	84 (64.23)	14.80	22.00	24.78	2.58	0.200
Clerodendran 1%	84 (64.23)	13.86	21.76	22.86	2.42	0.206
Clerodendran 2%	87 (65.11)	14.78	22.50	23.50	2.53	0.198
Clerodendran 3%	85 (64.80)	15.36	22.18	23.11	2.50	0.203
Calotropis 1%	85 (64.80)	14.12	20.84	22.60	2.38	0.199
Calotropis 2 %	88 (65.76)	14.85	21.75	23.00	2.49	0.207
Calotropis 3 %	80 (62.10)	14.20	21.54	22.85	2.42	0.210
Mean	86 (64.47)	14.86	21.90	23.74	2.50	0.201
SEd	1.78	0.41	0.37	0.45	0.04	0.002
CD (p=0.05)	(3.56)	0.83	0.65	0.90	0.08	0.004

Table 2: Effect of seed priming with herbal leaf extract on seed biochemical properties in maize

Treatments	Leachate amino acids ($\mu g\ g^{-1}$)	Leachate sugars ($\mu g\ g^{-1}$)	Lipid peroxidation (OD)	Dehydrogenase (OD)	Catalase (units g^{-1})	Peroxidase ($mg\ g^{-1}\ min^{-1}$)
Control	37.84	46.54	0.146	0.267	1126	0.230
Water	35.42	42.40	0.132	0.284	1347	0.284
Chicory 5 %	33.16	38.54	0.127	0.312	1790	0.332
Chicory 10 %	29.40	32.70	0.116	0.348	2243	0.378
Chicory 15 %	30.71	34.62	0.120	0.330	2060	0.346
Noni 1%	27.52	30.72	0.110	0.357	2356	0.390
Noni 2 %	28.70	33.56	0.117	0.340	2175	0.362
Noni 3%	31.20	35.46	0.125	0.322	1844	0.357
Clerodendran %	32.54	36.70	0.130	0.319	1800	0.326
Clerodendran 2 %	30.50	34.56	0.122	0.336	2190	0.352
Clerodendran 3 %	31.64	37.84	0.127	0.327	1940	0.337
Calotropis 1%	32.50	38.00	0.128	0.310	1720	0.317
Calotropis 2 %	31.47	34.91	0.121	0.326	2046	0.344
Calotropis 3 %	32.11	36.48	0.124	0.320	1880	0.326
Mean	31.76	36.64	0.125	0.321	1894	0.334
SEd	0.30	0.67	0.001	0.002	55	0.009
CD (P=0.05)	0.68	1.53	0.002	0.004	112	0.022

Table 3: Influence of seed priming and foliar nutrition with herbal leaf extract on yield parameters in maize cv.CO 1.

Treatments	Cob initiation (days)					Cob length (cm)				
	kharif 2012	*rabi* 2012-13		Pooled mean		*kharif* 2012	*rabi* 2012-13	Pooled mean		
Control	57	59		58.0		16.00	16.25	16.1		
Noni 1 % seed priming + chicory 5 % spray	52	53		52.5		19.32	18.12	18.7		
Noni 1 % seed priming + Noni 2% spray	52	51		51.5		20.75	21.60	21.2		
Noni 1 % seed priming + clerodendran 2 % spray	53	52		52.5		19.40	18.30	18.9		
Noni 1 % seed priming + calotropis 2 % spray	53	53		53.0		18.57	19.23	18.9		
Mean	54	54		54		19.51	19.31	19.40		
			S	T	SXT			S	T	SXT
SEd	0.4	0.5	0.7	0.7	1.7	0.82	0.68	0.6	1.1	1.6
CD (p=0.05)	0.8	1.0	1.3	1.4	NS	1.65	1.36	1.2	2.2	3.2

Table 4: Influence of seed priming and foliar nutrition with herbal leaf extract on yield Parameters in maize cv.CO 1.

Treatments	Seed yield (kg/ha)					100 seed weight (g)				
	Kharif 2012	*Rabi* 2012-13		Pooled mean		*Kharif* 2012	*Rabi* 2012-13		Pooled mean	
Control	5580	5614		5597		27.12	27.81		27.47	
Noni 1 % seed priming + chicory 5 % spray	6280	6315		6298		28.32	28.44		28.38	
Noni 1 % seed priming + Noni 2% spray	6655	6710		6683		28.86	28.93		28.90	
Noni 1 % seed priming + clerodendran 2 % spray	6338	6447		6393		28.04	28.33		28.19	
Noni 1 % seed priming + calotropis 2 % spray	6276	6217		6247		28.16	28.21		28.19	
Mean	6169	6191		6180		28.10	28.33		28.21	
			S	T	SXT			S	T	SXT
SEd	33	37	41	46	53	0.11	0.09	0.13	0.17	0.22
CD (p=0.05)	66	75	82	92	107	0.22	0.19	0.26	0.35	0.44

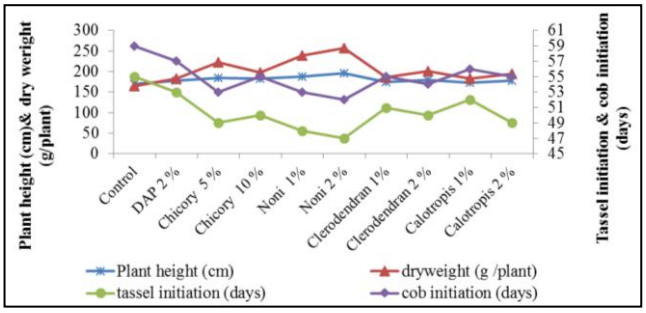

Fig 1: Efect of foliar nutrition with medicinal plant extract on growth and yield parameters in maize.

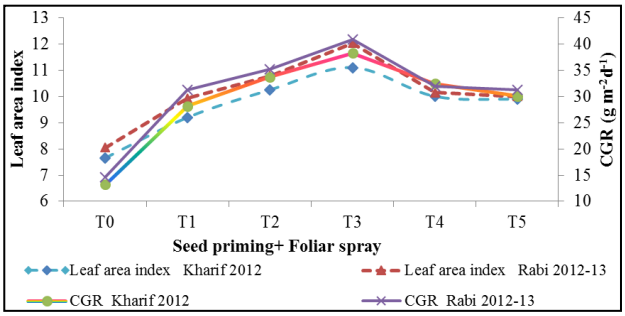

Fig 2: Effect of seed priming and foliar nutrition with herbal extract on growth parameters in maize.

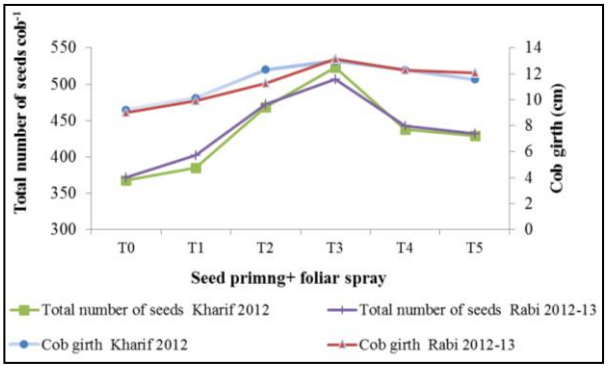

Fig 3: Efect of seed priming and foliar nutrition with herbal extract on yield parameters in maize.

References

1. Anitha Mummigatti UV, Madhusudhan Punithkumar. Effect of organic and inorganic seed priming on soybean. 2013; 4:223-230.
2. Balesevic S, Malenèiae D, Tatia M, Miladinovic J. Influence of aging process on biochemical changes in sunflower seed, Helia. 2005; 28:78-83.
3. Beckman KB, Ames BN. Oxidants, antioxidants and ageing In: Oxidative stress and the molecular biology of antioxidant defenses (Scandalios, J.G. (Ed.). New York, Cold Spring Harbor Laboratory Press, 1997, 201-246.
4. Bernheim F, Bernheim MLC, Wilbur KM. The reaction between thiobarbituric acid and the oxidation products of certain lipids. Journal of Biological Chemistry. 1948; 114:257-264.
5. Brabani A, Boggs LC, Katozi M, Sabouri H. Effects of seed deterioration and inoculation with *Mesorhizobium cicer on* yield and plant performance of chickpea. Australian Journal of Crop Science. 2011; 1:66-70.
6. Carlos LB, Scopel AL, Sanchez RA. Plant photomorphogenesis in canopies, crop growth and yield. Hort. Science. 1995; 6:1172-1181.
7. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research. John Willey and Sons, New York, 1984.
8. Guan LM, Scandalios JG. Catalase gene expression in response to auxin–mediated developmental signals. Physiologia Plantaram. 2002; 114:288-295.
9. Jeffers P, Kerins S, Baker CJ, Kieran PM. Generation of reactive oxygen and antioxidant species by hydrodynamically stressed suspensions of *Morinda citrifolia*, Biotechnology Progress. 2007; 23:138-145.
10. Kibinza S, Vinel D, Côme D, Bailly C, Corbineau F. Sunflower seed deterioration as related to moisture content during ageing, energy metabolism and active oxygen species scavenging. Physiologia Plantarum. 2006; 28:496-506.
11. Kittock DL, AG Law. Relationship of seedling vigour, respiration and tetrazolium chloride reduction by germination of wheat seeds. Agron. Journal. 1968;

60:286-288.
12. Kumar JP, Chaurasia AK, Bineetha MB. Effect of organic priming on germination and vigour of cotton (*Gossypium hirsutum* L.) seed. Journal of Pharmacognosy and Phytochemistry. 2017; 6:815-819.
13. Luck H. Assay of catalase. In: Methods in Enzymatic Analysis 2 (Bergmeyer (Ed), p. 885, Academic Press, New York, 1974.
14. Maguire ID. Speed of germination aid in selection and evaluation for seedling emergence and vigour. Crop Science. 1962; 2:176-177.
15. Major DJ, Dayanand S. Hyperbolic relation between leaf area index and plant population in corn (*Zea mays*). *Canadian.* Journal of Plant Sciences. 1972; 52:112-115.
16. Mandal AK, De BK, Saha R, Basu RN. Seed invigoration treatments for improved storability, field emergence and productivity of soybean (*Glycine max* L.). Seed Science & Technolology. 2000; 28:201-207.
17. Manjunathaswamy KK, Narayanaswamy R. Effect of natural ageing and seed rate compensation on crop growth performance and grain yield in hybrid maize (*Zea mays L.*). Seed Research. 1996; 24:93-96.
18. McDonald MB. Seed deterioration: Physiology, repair and assessment. Seed Science & Technolology. 1999; 27:177-237.
19. Patil SV, Halikatti SI, Hiremath SM, Babalad HB, Sreenivasa MN, Hebsur NS, *et al*. Effect of organics on growth and yield of chickpea (Cicer arietinum L.) in vertisols. Karnataka Journal of Agricultural sciences. 2012; 25:326-331.
20. Senthilkumar SK, Deepa T, Suganya M, Janakarajan J, Muralidhar Vasanthakumar P. Therapeutic properties of noni (*Morinda citrifolia*) and its products**,** International Journal of Science, Environment and Technology. 2016; 5:1496-1502.
21. Suneetha S, Kurdikeri MB, Shekhargouda M, Shashidhar SD. Effect of seed invigoration on storage potential of KBSH hybrid sunflower. Seed Research. 2003; 31:98-101.
22. Takashima J, Ikeda Y, Komiyama K, Hayashi M, Kishida A, Ohsaki A. New constituents from the leaves of *Morinda citrifolia*, Chemical and Pharmaceutical Bulletin. 2007; 55:343-345.
23. Thirukkumar S, Vennila P, Kanchana S, Uma Maheswari T. Studies on Extraction of Juice from Noni Fruits (*Morinda citrifolia* Linn.). Indian Journal of Natural Sciences. 2017; 7:11988-11994.
24. Verma SS, Tomer RPS, Verma U. Loss of viability and vigor in Indian mustard seeds stored under ambient conditions. Seed Research. 2003; 31:98-101.
25. Yang J, Paulino R, Janke-Stedronsky S, Abawi F. Free-radical-scavenging activity and total phenols of noni (*Morinda citrifolia* L.) juice and powder in processing and storage. Food Chemistry. 2007; 102:302-308.
26. Yasmeen A, Basra SMA, Wahid A, Nouman W, Rehman HU. Exploring the potential of Moringa oleifera leaf extract (MLE) as a seed priming agent in improving wheat performance. Turkey Journal of Botany. 2013; 37:512-520.