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Effect of integrated nutrient management on growth, flowering and yield of subtropical plum cv. Kala Amritsari

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Abstract
A field experiment was conducted to study the integrated response of application of organic and inorganic chemical fertilizers along with biofertiolizers (*viz.*, *Azotobactor* and Phosphate Solubilising Bacteria) on subtropical plum cv. Kala Amritsari, conducted during 2016-17 and 2017-18 at Experimental Orchard of Department of Horticulture, CCS Haryana Agricultural University, Hisar. It comprised of 11 treatment levels of plum in recommended block design with three replications. The main objectives were to study the effect of integrated nutrient management on growth, yield and quality of plum, to study the effect of integrated nutrient management on shelf life. Growth parameters of plum were significantly affected by the organic and inorganic fertilizer. The maximum increase in plant height (0.27 m), per cent increase in plant height (4.91 %), annual shoot growth (70.63 cm), leaf area (13.13 cm^2) and chlorophyll index (23.88) was observed in the treatment T_{11}: 75% of N + 12.5 % N through vermicompost + 12.5 % N through FYM+ biofertilizers. The maximum number of flowers/ feet of shoot (87.19), number of fruit set per feet of shoot (32.58), final fruit set (20.50%) and fruit firmness (4.01 kg/cm^2), fruit weight (12.35 gm), fruit yield per tree (53.43 kg/tree), were found significantly higher by the application of T_{11}: 75% of N + 12.5 % N through vermicompost + 12.5 % N through FYM+ biofertilizers, over all the treatment studied.

Keywords: INM, biofertilizers, growth, flowering, yield

Introduction
Plum (*Prunus salicina* Lindl.) is one of the important fruit crop grown in both temperate and subtropical region mainly, Himachal Pradesh, Jammu and Kashmir, Uttarakhand, parts of Punjab, Haryana, and Utter Pradesh. It is also distributed in North East and southern parts (Tamil Nadu) of Nilgiri and Kodaikanal. In India, area under plum cultivation is 22,000 ha and production is 76,000 MT (Anonymous, 2017) [1]. In Haryana, Plum is mainly grown in the districts of Panchkula, Ambala, Kurukshetra, Karnal, Sonipat, Rohtak, Hisar, Jind and Palwal, contributing at an area of about 68 ha with a production of 978 MT and is next important temperate crop to peach and pear in the state (Anonymous, 2016) [2]. Plum grown in Haryana, belongs to the Japanese group (*Prunus salicina* Lindl.), in which Kala Amritsari is an important table cultivar and is cultivated profitably in the mid hills below 800 m above mean sea level. Under the shifting climatic condition, subtropical plum cultivation has gained its importance amongst the commercial fruit growers because of its wide range of adaptability to climatic condition and more remunerative price. Kala Amritsari, plum has been found to be self-fruitful and flowers profusely. It's an early variety which bears attractive and juicy fruits. Thus it has been proved to be a money spinner for plum growing areas of Haryana. Since fertilizers constitute a major costly input for maximising production and exploitation of yield potentiality of fruit crops. High fertility levels not only put a heavy financial burden to the basic system of production, but also use of only chemical fertilizers as a source of nutrients has decreased nutrient use efficiency (Pandey *et al.*, 2017). Due to this, the crop productivity has been declined, for reclaiming this and to reduce negative effect on soil health, the organic matter and bio-fertilizers along with inorganic fertilizers need to be applied. The integrated nutrient management infuses long term sustainability in the productivity level without deteriorating soil health.

Organic manures such as farm yard manure and vermicompost (excreta of earthworms), rich in humus and a nutrient are advantage in association with microorganisms such as *Azotobacter*, *Azospirillum*, Phosphate solubilising bacteria *etc.*) (Singh *et al.*, 2017) [26] and also effective means for improving soil aggregation, structure and fertility, increasing microbial diversity and population, improving moisture holding capacity of soils, increasing the soil cation exchange capacity and consequently crop yields (Zink and Allen, 1998) [34].

The supplying of NPK, farm yard manure improves the physical, chemical and biological status of soil; apart from this also supply N, P, and K to soil.

Bio-fertilizers are microbial inoculants which are capable of mobilizing nutritive elements from non soluble to soluble form through biological process. They are useful in increasing yield and quality, when used in combination with organic manures and organic fertilizers in a balanced proportion. Biofertilization is beneficial in stimulating plant growth and development, and fruit production & quality of pome and stone fruits (Maloguti *et al.,* 2002, Von Bennewitz and Hlusek, 2006, Gross *et al.,* 2008; Takur and Takur, 2014) [13, 32, 7].

Materials and Methods

The present investigations were carried out at the experimental orchard of Department of Horticulture, CCS HAU., Hisar, during 2017 and 2018. The experimental orchard is situated at an altitude of 215.2 m above average mean sea level and lies at 29º 10' N latitude and 75º 46' E longitudes. The experimental site comes under typical semi-arid climatic zone with hot and dry summer and extremely cold winter. It shows a wide range of fluctuations between the mean monthly maximum and minimum temperatures both during summer and winter months. The experimental field soil was sandy loam in texture, non-saline, medium in organic carbon, low in available nitrogen, high in available phosphorus and rich in available potassium. The experiment consisted of thirty three trees of nineteen year old with uniformly grown trees, spaced at 6 m x 6 m were selected randomly by eliminating the border trees and were kept under uniform condition of orchard management, where all the agronomic practices were carried out as per package of practices.

The various growth parameters like, plant height, increase in plant height, percent increase in plant height, annual shoot growth, leaf area and chlorophyll index was recorded by using standard methods. For annual shoot growth, ten annual shoots were randomly selected from all over the periphery of the tree and their length was measured with the measuring tape at the end of growing period and expressed in centimetre. The Leaf area (cm^2) was recorded by randomly collecting twenty five fully developed leaves from all directions of the tree periphery, measured with the help of Automatic Leaf Area Meter (Licor Model-3100) and expressed in square centimetre. Chlorophyll index (Spad reading) was measured by using portable chlorophyll meter (SPAD-502) used for estimating total chlorophyll amounts in leaves in a non-destructive method (Neufeld *et al.,* 2006).

The Flowering intensity was calculated by selecting five branches on all the sides of each treatment were marked and the total number of flowers per feet of branch was counted and expressed in numbers. The number of fruit set (initial) was counted after fruit setting by selecting ten fruiting shoots from all the sides of tree. Final fruit set were recorded before two weeks of harvesting from the tree. The fruit yield from each experimental tree was determined on the basis of total weight of fruits harvested from the tree under each treatment and average yield per tree was calculated and expressed in kg per tree. The weight of ten fruits was recorded on electronic balance and the results were expressed in grams per fruit. The fruit firmness of randomly selected fruits was determined by a pressure tester (Digital fruit tester) which recorded the pressure necessary for the plunger to penetrate the flesh of plum fruits and was expressed in kg/cm^2.

Treatment details

Plum is a heavy bearer, needs regular supply of plant nutrients, at present study was undertaken to reduce the chemical fertilizer (nitrogen) and was supplied through the various organic sources (*viz,* Vermicompost and FYM). During the study the vermicompost contain 1.01 % of nitrogen and FYM contains 0.5% of nitrogen, it was calculated accordingly and applied in the month of December and 50% of chemical fertilizers are applied after 50% of flowering. The biofertilizers (*Azatobactor* and Phosphate Solubilising Bacteria @50 ml each) applied through the organic fertilizers. The different treatments (11) applied during the experiments are as followed, T_1: Control (RDF) (165g N:96g P:216g K:36kg FYM), T_2: 50% of N + 50% N through FYM, T_3: 75% of N+ 25% N through FYM, T_4: 50% of N + 50% N through vermicompost, T_6: 50% of N + 50% N through vermicompost + biofertilizers, T_7: 75% of N+ 25% N through vermicompost + biofertilizers, T_8: 50% of N + 50% N through FYM + biofertilizers, T_9: 75% of N + 25% N through FYM + biofertilizers, T_{10}: 50% of N + 25% N through vermicompost + 25% N through FYM + biofertilizers and T_{11}: 75% of N + 12.5 % N through vermicompost + 12.5 % N through FYM+ biofertilizers.

Table 1: Effect of INM on various growth parameters in plum cv. Kala Amritsari

Treatments	Plant height (m)	Increase in plant height (m)	Percent increase in plant height	Annual shoot growth (cm)	Leaf area (cm^2)	Chlorophyll index (Spad reading)
T_1	5.40	0.14	2.59	43.47	9.55	23.28
T_2	5.46	0.23	4.26	43.90	9.87	18.85
T_3	5.66	0.21	3.84	46.80	10.09	19.70
T_4	5.49	0.18	3.26	50.85	9.78	18.28
T_5	5.63	0.21	3.74	54.75	10.72	20.39
T_6	5.94	0.18	3.07	62.02	11.13	24.31
T_7	5.99	0.22	3.67	61.33	11.86	19.66
T_8	5.64	0.23	4.14	54.58	11.03	20.22
T_9	5.53	0.28	5.17	54.27	10.82	22.46
T_{10}	5.91	0.23	4.01	63.28	12.53	21.18
T_{11}	6.01	0.34	5.82	64.45	13.12	26.03
C.D.(0.05)	0.21	0.06	1.14	2.53	0.62	2.60

Table 2: Effect of INM on various yield and yield contributing attributes in plum cv. Kala Amritsari

Treatments	Number of flowers/ feet shoot	Number of fruit set /feet shoot	Final fruit set (%)	Fruit Weight (gm)	Fruit firmness (kg/cm^2)	Fruit Yield (kg/tree)
T_1	75.93	25.50	19.32	10.90	3.18	42.87
T_2	75.27	22.24	19.64	9.65	3.65	38.63
T_3	75.35	27.25	20.46	9.97	3.61	42.55
T_4	72.36	25.10	21.47	9.20	3.87	39.40
T_5	80.28	28.68	21.78	10.14	3.90	46.38
T_6	75.34	25.91	22.23	9.92	3.69	46.07
T_7	73.81	27.22	22.81	11.30	3.37	47.95
T_8	78.77	28.88	22.04	10.15	3.61	47.12
T_9	77.92	29.77	22.93	11.71	3.93	49.53
T_{10}	83.91	28.11	22.06	11.84	3.88	50.06
T_{11}	87.19	32.58	23.50	12.35	4.01	52.14
C.D.(0.05)	3.34	1.34	0.88	0.28	0.36	1.54

Result and Discussion

Effect on growth parameters

In plum, nitrogen play important role in plant growth and development, the excess and too low application may hinder growth and flowering of plant. So, by reducing the nitrogen dose and applied in the form of organic fertilizers (*viz.,* FYM and vermicompost) along with biofertilizers (*viz., Azatobactor* and PSB) help to restore nitrogen and make it for available form.

The data presented in (Table 1) showed that the maximum plant height (6.01 m), increase in plant height (0.34 m) by the application of the treatment T_{11} followed by T_9 with 0.28 m and minimum increase in plant height were reported in T_1 (Control) with 0.14 m, respectively. Hence, the present findings exposed that the integrated application of organic and chemical fertilizers was the best treatment for better tree growth. This increase in shoot growth might be due to increase in uptake of nutrients and increased release of growth factors (*viz.,* auxins, gibberellins and cytokinins) in root zone. Increased uptakes of N and increase in release of growth factors in the root zone have been reported by different workers (Singh, *et al.* 2010 and Hazarika and Ansari, 2010) [23]. Moreover, the release of nutrients might be considered with the physiological stage which resulted in proper root growth and enhanced nutrient uptake which was reflected in all growth parameters (Musmade, *et al.* 2010) [14].

This might be due to the increased photosynthetic rate and carbohydrate accumulation as a result of multifarious role of vermicompost and FYM to allow most favourable conditions of soil with increased availability of plant nutrients responsible for better plant growth (Sharma and Bhutani, 2000; Tiwari, *et al.* 1999 and Dutta, *et al.* 2009) [21, 30, 6]. The free living nitrogen fixer (*Azotobacter*) can affect plant growth not only by fixing nitrogen but also by altering microbial balance, solublizing fixed soil phosphorus, suppressing pathogenic microorganisms and by producing metabolites that stimulate plant development. This is an indication of the fact that biofertilizers and compost hasten the vegetative growth by virtue of their nutrient releasing properties.

The higher vegetative growth due to the application of growth promoting *Azotobacter* that improved P and N availability and thereby causing higher protein synthesis resulting in improved morphological growth (Singh and Singh, 2004) [22] among all the treatments, chemical fertilization, organic and biofertilizers application reported improvement in growth over control and proved inadequate compared with organic fertilizers. This might be due to the lack of organic matter in the treatment and unavailability of soil nutrients (Naik and Babu, 2007) [15]. The applications of *Azotobacter* promote nitrogen fixation and biosynthesis of plant growth regulators (*viz*., IAA, GA_3) and hence positively affect the growth of fruit trees (Khalid, *et al.* 2004 and Singh, *et al.* 2017) [10].

The maximum per cent increase in plant height in T_{11} with (5.82 %) and minimum was reported in T_1 (2.59 %). the maximum annual shoot growth in T_{11} (64.45 cm) followed by T_{10} (63.28 cm). Leaf area recorded maximum in T_{11} (13.12 cm^2) followed by T_{10} (12.53 cm^2) and minimum in T_1 (9.55 cm^2). The maximum chlorophyll index in T_{11} (26.03) and minimum was reported by the application of the treatment T_4 (18.28). The maximum percent in plant height may be due to the increase in plant height. It may be due to the increase in plant height by the conjoint application of integrated nutrients *viz.*, organic and chemical fertilizers along with the addition of biofertilizers.

Increase in shoot growth is due to increased nutrient availability (N, P, K and micronutrients) by the stimulative activity of microflora in the rhizosphere and it enhance vigorous growth of plant. The increase in vegetative growth could be attributed to the higher amount of nutrients and some growth stimulating substances excreted by earthworms in their casts and biofertilizers (*Azotobacter* and PSB). Better growth in organic culture has been reported due to enhancement in soil microbial activity (PSB and *Azotobacter*), leading to higher N-fixation and phosphate mobilization which corroborated the present findings (Korwar, *et al.* 2006). The similar finding was also reported by Thakur and Thakur (2014).

Effect on yield and yield contributing attributes:

The maximum number of flowers / feet of shoot was reported in the treatment T_{11} (87.19), followed by T_{10} (83.91) whereas, minimum was reported in the treatment T_2 (75.27). The maximum number of fruit set per feet of shoot by the application of treatment T_{11} (32.58) followed by T_9 (29.77), while minimum was reported in the treatment T_2 (22.24). It may be due to more number of flowers per feet of shoot, may increase the number of fruit set. The maximum final fruit set was reported in the treatment T_{11} (20.50) followed by the treatment T_{10} (18.53). It may be due availability of maximum nutrients in the rhizosphere, may help of more production of photosynthates, that will build for increasing final fruit set and fruit development. The increase in fruit set in the present studies might be due to maximum availability of nutrients in the rhizosphere with integrated application of bio-organic and chemical fertilizers or their cumulative effect have increased translocation of metabolites from roots to flower to enhance pollen germination and pollen tube growth and hence

increased fruit set and number of fruits per plant (Singh *et al.* 2010; Naik and Babu, 2007 [15], Thakur and Thakur, 2014 and Soni, *et al.* 2018) [10, 29].

The increased nutrient availability from the organic matter and FYM might have increased various endogenous hormonal levels (*viz.*, Auxin and GA_3) in the plant tissue might be responsible for enhanced pollen germination and tube growth, ultimately increased the fruit set as well as number of fruit per plant **(**Sumner, 1990, Mahendra, *et al.*, 2009 and Bhat, *et al.* 2017) [28, 12]. The soil applications of *Azotobacter* and PSB, apart from enhancing the availability of N and P to the plant roots but also increase their rate of translocation from roots to flowers by developing intensively an extensive extra radical mycelium which helps the plants in exploiting mineral nutrients and water from the soil. The application of biofertilizers stimulate the rate of biosynthesis of plant growth regulators (*viz.*, auxin, gibberellins and cytokinin) which established the endogenous balance between promoters and inhibitors in favour of fruit promoting process (Awasthi, *et al.* 1998, Pilania, *et al.* 2010 and Wong, *et al.* 2015) [3, 17, 33].

The maximum fruit weight (Table 2) was reported in T_{11} (12.35 gm) and minimum was reported T_2 (9.65 gm). It may be due to translocation of maximum photosynthates to the fruits. Maximum fruit firmness in T_{11} (4.01 kg/cm^2), was found at par with T_9 (3.93 kg/cm^2), T_{10} (3.88 kg/cm^2), T_5 (3.90 kg/cm^2), T_4 (3.87 kg/cm^2), T_6 (3.69 kg/cm^2) and T_2 (3.65 kg/cm^2), and minimum was reported in T_1 (3.18 kg/cm^2), respectively. Increase in the fruit size, fruit weight and fruit volume by application of chemical fertilizers was reported by Sharma and Bhargava (2003) [20] in plum. This might be attributed to enhancement of nitrogen status of the tree. Nitrogen is directly involved in the synthesis of protein and amino acids, which helps to enhance the production of spongy type cells of fruits. Moreover, N is highly mobile nutrient and helps for developing fruits, instead also act as metabolic sink for nutrients and photosynthates (Prasad, 2005) [18]. The fruit quality of strawberry cv. Chandler, *viz.* total soluble solids, total sugars, ascorbic acid and anthocyanin content, was recorded by soil application of 25% nitrogen through FYM + 75% nitrogen in the form of urea + *Azotobacter* (Umar *et al.*, 2009).

Yield is a complex character which involves the interaction of several intrinsic and external factors. It largely depends upon the production and mobilization of carbohydrates, uptake of nutrients and water from the soil and the hormonal balance, in addition to several environmental factors to which tree is exposed during the growing period. Yield has been significantly affected by various treatments during the course of investigation. The maximum fruit yield was reported by the application of the treatment in T_{11} (52.14 kg/tree) and minimum in T_2 (38.63 kg/tree). The increase in the yield was mainly attributed to relative increase in the availability of nutrients and better solute uptake by the plants. These findings are in accordance with the results of Korwar, *et al.* (2006) [10] and Soni, *et al.* (2018) [27]. The effectiveness of chemical fertilizers was greatly enhanced, when it was applied along with FYM, this might have resulted due to better retention of urea in root zone (Chin and Kroonje, 1963 and Patil, *et al.* 2017) [16] and better availability of potash and phosphate to the plants by applying organic matter (Raychoudhuri, 1976) [19]. These findings indicated that application of integrated nutrients *viz.*, FYM, vermicompost, biofertilizers and along with chemical fertilizers were successful in maintaining higher levels of plum productivity. The present findings of increasing fruit yield by integrated application of organic manures and chemical fertilizers along with biofertilizers are in congruence with the findings of Krishna, *et al.* (2018) reported highest fruit yield per plant by the application of inorganic + organic source combination wherein 50 per cent RDN was replaced through vermicompost along with biofertilizers. The present findings of increasing fruit yield by combined application of organic manures with inorganic fertilizers are in congruence with the findings of Thakur and Thakur, (2014) [29] who was reported maximum yield by the application of 75% NPK + biofertilizers (60 g each/tree basin) + green manuring (Sun hemp @ 25 g seeds/tree basin).

Conclusion

Among various treatment studied, the treatment T_{11} had reported maximum plant height, increase in plant height, percent increase in plant height, leaf area and total chlorophyll content, number of flowers, fruit set, fruit weight and fruit yield.

References

1. Anonymous, Horticulture statistics at a glance-2017. Horticulture statistics division, department of agriculture, cooperation & farmer's welfare ministry of agriculture & farmers welfare, Government of India, 2017, 142.
2. Anonymous, Revised area and production of fruit crop during the year 2015-2016. Horticultural department, Government of Haryana, 2016.
3. Awasthi RP, Godara RK, Kainth NS. Interaction effect of VA mycorrhizae and *Azotobacter* inoculation on micronutrient uptake by peach seedlings. Horticultural Journal. 1998; 11(2):1-5.
4. Bhat S, Lal RL, Misra KK, Singh DK. Response of organic formulations on fruiting and yield of litchi (*Litchi chinensis* Sonn.) cv. Rose Scented. Journal of Pharmacognosy and Phytochemistry. 2017; 6(6):2092-2095.
5. Chin WT, Kroonje W. Urea hydrolysis and subsequent loss of ammonia. Proc. Soil Sci. Soc. Amer. 1963; 27:316-318.
6. Dutta P, Maji SB, Das BC. Studies on response of bio-fertilizer on growth and productivity of guava. Indian Journal of Horticulture. 2009; 66(1):39-42.
7. Gross AR, Arusi PF, Nejidat A. Assessment of extraction methods witf fowl manure for the production of liquid organic fertilizers. Bioresour Technol. 2008; 99:327-334.
8. Hazarika BN, Anasri S. Effect of integrated nutrient management on growth and yield of banana cv. Jahaji. Indian Journal of Horticulture. 2010; 67(2):270-273.
9. Khalid A, Arshad M, Zahir ZA. Screening plant growth-promoting rhizobacteria for improving growth and yield of wheat. Journal of Applied Microbiology. 2004; 96:473-480.
10. Korwar GR, Pratibha G, Ravi V, Palanikumar D. Influence of organics on growth, yield of aonla (*Emlica officinalis* L.) and soil quality in semi-arid tropics. Indian Journal of Agricultural Sciences. 2006; 76(8):457-461.
11. Korwar GR, Pratibha G, Ravi V, Palanikumar D. Influence of organics on growth, yield of aonla (*Emlica officinalis* L.) and soil quality in semi-arid tropics. Indian Journal of Agricultural Sciences. 2006; 76(8):457-461.
12. Mahendra SHK, Singh JK. Studies on integrated nutrient management on vegetative growth, fruiting behavior and soil fertilizer status of ber (*Zizypus mauritiana* Lamk.)

orchard cv. Banarasi Karaka. The Asian Journal of Horticulture. 2009; 4(1):230-232.
13. Maloguti D, Romkola AD, Gerin M, Simoni G, Tagliavini M, Marangoni B. Effect of seaweed extracts based leaf sprays on the mineral status, yield and fruit quality of apple. Acta Horticulturae. 2002; 594:223-227.
14. Musmade AM, Jagtap DD, Pujari CV, Hirayi SA. Integrated nutrient management in acid lime. Asian Journal of Horticulture. 2010; 4(2):305-308.
15. Naik MH, Srihari BR. Feasibility of organic farming in guava. Acta Horticulturae. 2007; 735:365-371.
16. Patil MB, Shinde SE, Panchal VM. Influence of organic-inorganic nutrient management practices on growth and yield of sweet orange var. Nucellar (*Citrus sinesis* L. Osbeck). International Journal of Chemical Studies 2017; 5(4):563-566.
17. Pilania S, Shukla AK, Mahawer LN, Rajvir S, Bairwa HL. Standardization of pruning intensity and integrated nutrient management in meadow orcharding of guava (*Psidium guajava* L.). Indian Journal of Agricultural Sciences. 2010; 80(8):673-678.
18. Prasad RN. Effect of N and P on growth, yield and quality of ber grown under rainfed conditions of Indian arid zone. Indian Journal of Horticulture. 2005; 62(4):404-406.
19. Raychoudhuri SP. Phosphatic and potassic fertilizers and their management. In: Soil fertility theory and practices. Kanwar, J. S (ed.). 1976, 371-407.
20. Sharma JK, Bhargava JN. Effect of different carriers of nitrogen on fruit set, growth and quality of Santa Rosa plum. Haryana Journal of Horticultural Science. 2003; 32(1/2):34-36.
21. Sharma SD, Bhutani VP. Physiology of crop species systemically infected with viruses. Journal of Hill Research 2000; 13(2):63-66.
22. Singh A, Singh SP. Response of banana (*Musa sp.*) to vesicular arbuscular mycorrhizae and varied levels of inorganic fertilizers. Indian Journal of Horticulture 2004; 61(2):109-113.
23. Singh VJ, Sharma SD, Kumar P, Bhardwaj SK. Raj H. Conjoint application of bio-organics and inorganic nutrient sources for improving cropping behaviour, soil properties and quality attributes of apricot (*Prunus armeniaca* L.). Indian Journal of Agricultural Sciences 2010; 80(11):981-987.
24. Singh VJ, Sharma SD, Kumar P, Bhardwaj SK Raj H. Conjoint application of bio-organics and inorganic nutrient sources for improving cropping behavior, soil properties and quality attributes of apricot (*Prunus armeniaca* L). Indian Journal of Agricultural Sciences 2010; 80(11):981-987.
25. Singh VK, Prasad VM, Supriya K, Preeti R, Pragati M. Identification of the suitable hardening protocol and hardening medium in micropropagation of gerbera (*Gerbera jamesonii* Bolus). Int. J. Current Microbiol. App. Sci. 2017; 6(7):2476-2484.
26. Singh Y, Satya P, Om P, Dharmendra K. Effect of integrated nutrient management on fruit yield and quality of Amrapali mango (*Mangifera indica* L.) under high density planting, Int. J Pure App. Biosci. 2017; 5(3):67-73.
27. Soni S, Amit K, Rajkumar C, Praval SC, Rahul K. Saurabh D. Effect of organic manure and biofertilizers on growth, yield and quality of strawberry (*Fragaria X ananassa* Duch) cv. Sweet Charlie, Journal of Pharmacognosy and Phytochemistry 2018; 2:128-132.
28. Sumner ME. Crop response to *Azospirillium* inoculation. Advances of Soil Science. 1990; 12:53-123.
29. Thakur N, Thakur BS. Studies on the effect of integrated nutrient management on growth and yield of plum cv. Santa Rosa. The Asian Journal of Horticulture. 2014; 9(1):112-115.
30. Tiwari DK, Hasan MA, Chattopadhyay PK. Effect of biofertilizers on soil nutrient status and microbial population in banana plantation. Environment and Ecology. 1999; 17(2):338-341.
31. Umar I, Wali VK, Kher R, Akash S. Impact of integrated nutrient management on strawberry yield and soil nutrient status. Applied Biological Research. 2008; 10:22-25.
32. Von Bennewitz E, Hlusek J. Effect of the application of two bio preparations on the nutritional status, vegetative and generative behaviour of Jonagold apple trees. Acta Horticulturae. 2006; 721:220-226.
33. Wong WS, Tan SN. Ge L, Chen X, Yong JWH. The importance of phytohormones and microbes in biofertilizers. D. K. Maheshwari (ed.), Springer International Publishing Switzerland, Bacterial metabolites in sustainable agroecosystem, sustainable development and biodiversity. 2015; 2:105-158.
34. Zink TA, Allen MF. The effect of organic amendments on the restoration of a disturbed coastal sage scrub habitat. Restor Ecol. 1998; 6:52-58.