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Impact of integrated nutrient management practices on nutrient uptake and yield of wheat under Poplar based agroforestry

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Abstract
An experiment was conducted to study the effect of farm yard manure, vermicompost and inorganic fertilizers on wheat nutrient content and uptake conducted during the *rabi* season of 2017-2018 at Experimental site of Agroforestry Research Centre (old site) near Horticulture Research Centre, Patharchatta of G.B. Pant University of Agriculture and Technology, Pantnagar. The soil of the experimental site belonged to Makota-III clay loam as surface texture, neutral in reaction, low in nitrogen, medium in available phosphorus and potassium but high in organic carbon. The experiment was laid out in Randomized Block Design replicated thrice with nine treatments *viz*. T1 (Open Control), T2 (Control under poplar agroforestry), T3 (100% RDF), T4 (100% RDN through FYM), T5 (100% RDN through VC), T6 (50% RDN through FYM + 50% RDN through urea), T7 (50% RDN through VC + 50% RDN through urea), T8 (50% RDN through FYM + 50% RDN through VC) and T9 (50% RDN through organics (25% FYM + 25% VC) + 50% RDN through urea). Four irrigations were given at different critical stages of the crop including a pre sowing irrigation. Results showed that T9 and T7 significantly influenced the N, P and K content and its respective uptake in grain and straw as well as in wheat yield. Difference between two controls T1 and T2 were also noted on yield basis due to incorporation of leaf litter of poplar in T2.

Keywords: Integrated nutrient management, poplar, agroforestry, wheat, vermicompost

Introduction
Wheat is the second most needed grain, and has also been defined as "the king of cereals or life workers" and one of the world's most popular staple food crops. As a human diet it has its own extraordinary importance; it is abundant in carbohydrates and protein (Ram and Mir, 2006) [12]. The wheat is grown in almost 43 countries around the world. The leading countries in wheat production are China, India, Thailand, Indonesia and the U.S.A (Kharub and Sharma, 2002) [6].
The Indian subcontinent soil has been low in certain nutrients owing to intensive agriculture and imbalanced and indiscriminate usage of fertilizer, and is therefore depleted of organic matter. This area has now begun to prioritize a change from inorganic to organic production to ensure soil quality and avoid nutrient mining (Pandey *et al*., 2009) [11]. However, a full transition to an organic farming program is not feasible because of the increasingly growing demands for food from this region's ever-rising populations (Kumar *et al*., 2011) [7].
Conjoined application of organic and inorganic nutrients to the field not only improves yield and productivity but also tends to preserve the fertility level of soil (Hedge, 1998) [3]. For better yield and good soil health, use of organic manure and bio-fertilizers along with chemical fertilizers is needed. The combination of inorganic fertilizers with organic manures and bio-fertilizers would not only help sustain crop production but will also be successful in boosting soil quality and enhancing the output of nutrient usage (Katyal *et al*., 2002) [4]. The INM strategy is focused on preserving the supply of plant nutrition to achieve a certain degree of crop production by cohesively maximizing the benefits of all possible plant nutrition sources, relevant to each crop trend and farming situation (Kaushik *et al*., 2012) [5]. Organic manure inclusion controls nutrient absorption, positively affects growth, enhances soil quality (physical, chemical, and biological) and generates synergistic effects on crops (Singh *et al*., 2007) [14]. The uptake of nutrients by any crop depends largely on plant output of biomass. However, the accumulation of various nutrients inside the plant system often influences their overall uptake (Bajpai *et al*., 2006) [1].
In view of the above, the present experiment was performed with the intention of investigating the benefits of integrated nutrient management in terms of nutrient uptake and wheat yield under poplar-based agroforestry conditions.

Material and methods

The present investigation was conducted at Experimental site of Agroforestry Research Centre (old site) near Horticulture Research Centre, Patharchatta of G.B. Pant University of Agriculture and Technology, Pantnagar during the month of November to April, 2017-18. Geographically the site was situated in *Tarai* region of Uttarakhand at latitude of 28.97o N, 79.41oE longitude and an altitude of 243.84 meter above mean sea level. Pantnagar had humid sub-tropical climate with heavy rains in monsoon season. Mean annual rainfall was 1400mm. The soils of *Tarai* region were poorly developed alluvial soils. These soils were developed from moderately coarse textured alluvial parent material under the influence of tree vegetation. The soil of the experimental site belonged to Makota-III clay loam as surface texture, neutral in reaction, low in nitrogen, medium in available phosphorus and potassium but high in organic carbon. The experiment was laid out in Randomized Block Design replicated thrice with nine treatments *viz*. T1 (Open Control), T2 (Control under poplar agroforestry), T3 (100% RDF), T4 (100% RDN through FYM), T5 (100% RDN through VC), T6 (50% RDN through FYM + 50% RDN through urea), T7 (50% RDN through VC + 50% RDN through urea), T8 (50% RDN through FYM + 50% RDN through VC) and T9 (50% RDN through organics (25% FYM + 25% VC) + 50% RDN through urea). The wheat seeds were obtained from Seed Production Centre, GBPUA&T, Pantnagar and the vermicompost and farm yard manure were sourced from Livestock Research Centre, Nagla, GBPUA&T, Pantnagar. Recommended dose of fertilizer (RDF) for wheat was $N_{120}P_{60}K_{40}$. Nitrogen application for FYM and VC were calculated on N equivalent basis of RDF. 100% phosphorus through Single Super Phosphate and potash through Muriate of Potash were applied as basal in T3. Well-decomposed FYM and VC were added to the plots as per treatment two weeks prior to sowing. The wheat variety HD 3086 was sown on 7th November 2017 at a seed rate of 125 kg ha^{-1}. Row spacing was kept at 20 cm. Wheat seeds were treated with captan 2 g kg^{-1} of seeds to protect crop against seed borne diseases. Four irrigations were given at critical stages of crop growth and all other recommended packages of practices were adopted during the crop-growth period. Harvesting of crop was done with the help of sickles manually by cutting the plants from the net area of each plot separately on 10th April 2018. Soil samples were collected after harvesting of wheat crop from each plot with the help of auger at 0-15 cm depth.

Five representative plants from each plot were selected randomly and tagged for recording the effect of different treatments on yield attributes. All yield attributes were recorded periodically on these tagged plants. The uptake of nitrogen, phosphorous and potassium (kg ha^{-1}) was calculated on the basis of nutrient content on dry weight basis of grain and straw. Oven dried grain and straw samples weighed 0.2 and 0.5 g, respectively were digested in diacid mixture of H_2SO_4 and $HClO_4$ in the ratio of 9:1 for nutrients (N, P) estimation. After the digestion, a known volume was made with distilled water and stored in well washed plastic bottles after filtration through Whatman filter paper No. 42. Nitrogen content in digested plant material was determined by Nessler's reagent method. Phosphorus content was determined by Vanadomolybdo phosphoric acid yellow colour method, respectively. Nutrient uptake was computed as below:

$$\text{Nutrient uptake by grain (kg per ha)} = \frac{\text{percent nutrient content in grain x grain yield (q ha}^{-1})}{100}$$

$$\text{Nutrient uptake by straw (kg per ha)} = \frac{\text{Per cent nutrient content in straw x straw yield (q ha}^{-1})}{100}$$

The total produce from the net plot area was threshed, cleaned and weight of the grains was recorded in kg. The grain yield thus obtained was expressed in quintal per hectare. Straw yield was worked-out by subtracting the grain yield from biological yield and expressed in quintal per hectare.

Results and Discussion

Among various integrated nutrient management approach, treatment T9 produced significantly higher N uptake in grain and straw followed by treatment T3 and T7. Similarly highest value of P uptake in grain and straw and was recorded in treatment T9, followed by treatment T3 and T7. Treatment T9 produced significantly maximum potassium uptake in wheat grain and straw. However, T3 was at par to T7 and T6 in K uptake by grain but for straw K uptake, T3 was at par to T7 (Table 1).

Table 1: Effect of integrated nutrient management on nitrogen, phosphorus and potassium uptake (kg ha^{-1}) by wheat

Treatment	Nitrogen uptake (kg ha^{-1})		Phosphorus uptake (kg ha^{-1})		Potassium uptake (kg ha^{-1})	
	grain	straw	grain	straw	grain	straw
T1	36.70	9.68	5.42	2.68	6.97	33.83
T2	41.18	10.94	6.67	3.30	8.42	35.28
T3	59.10	29.59	12.18	6.28	21.32	56.10
T4	48.16	21.02	10.26	3.89	17.22	38.34
T5	51.93	22.38	10.42	4.39	17.54	40.41
T6	55.45	26.18	11.32	5.36	18.37	48.21
T7	56.44	27.52	11.74	6.04	19.09	54.20
T8	53.54	23.18	10.79	4.73	17.89	43.63
T9	65.60	30.16	13.79	6.33	24.58	58.85
C.D. (5%)	6.96	3.45	1.87	0.92	3.08	4.06
SE(m) ±	2.30	1.14	0.62	0.30	1.02	1.34

In terms of grain yield (Table 2), T9 produced maximum quantity of grain and had an increase over T1 by 46.4% and by 32.2% over T2. T9 also gave maximum straw yield (5.37 tonne ha^{-1}) followed by T3 and T7 but were statistically at par to one another. Highest total yield was obtained in T9 followed by T7. T9 was at par to T7 but had an increase over T1 by 32%.

Table 2: Effect of integrated nutrient management on grain, straw and biological yield (tonne ha^{-1}) of wheat

Treatment	Crop yield (tonne ha^{-1})		
	grain	straw	total
T1	2.87	4.26	7.13
T2	3.19	4.48	7.68
T3	3.74	5.34	9.08
T4	3.39	4.58	7.98
T5	3.46	4.70	8.15
T6	3.60	5.26	8.86
T7	3.62	5.33	8.95
T8	3.51	4.77	8.27
T9	4.10	5.37	9.47
C.D. (5%)	0.46	0.42	0.66
SE(m) ±	0.15	0.14	0.22

The rise in N absorption with the application of fertilizer could be attributed to a change in the N quality of plant tissue and a rise in dry matter accumulation and grain yield. Behera *et al.*, (2007) [2] stated that the inoculation of seeds with phosphate solubilizing microorganisms vastly improved the intake of nitrogen, which could be attributed to enhance phosphorus supply and intake, which is believed to be linked positively to nitrogen intakes. Rasool *et al.*, (2008) [13] noted maximum uptake of P (18.1 kg ha^{-1}) in wheat with 50 percent N through FYM + 50 percent through RDF and was on a par with 25 percent N through FYM + 50 percent through RDF or 100 percent through NPK. Mubarak and Singh (2011) [10] recorded a higher absorption of K in wheat treated with 50 percent N through FYM+50 percent through RDF which was equivalent to 25 percent N through FYM+50 percent through RDF and 100 percent through NPK. Kumpawat and Rathore (2002) [8] have noted that increment in NPK had a distinct impact on grain and straw uptake of K. Because of better root proliferation and growth in conjoined nutrient treatment, higher total uptake of N, P and K was observed (Majundar *et al*., 2008) [9].

Conclusion

From the results thus obtained, it can be concluded that use of different nutrient sources produced significant increase in nutrient uptake by both grain and straw of wheat as well as enhanced crop yield. This is because conjoined use of organic and inorganic nutrients were may be able to increase the soil available nitrogen, phosphorus and potassium contents due to improvement in soil physical structure and increased microbial enzymatic activities.

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