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Integrated nitrogen management of young deciduous apricot orchard

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Abstract

A long term field experiment was conducted on young deciduous apricot fruit orchard that was planted during January 2002. After establishment of plants, the experimental treatments were imposed during January 2003. The treatments consisted of T_1 (control), T_2 (100% mineral N), T_3 (75% mineral N + 25% N as farmyard manure), T_4 (50% mineral N + 25% N as farmyard manure + 25% N as poultry manure), T_5 (25% mineral N + 50% N as farmyard manure + 25% N as poultry manure) and T6 (25% mineral N + 25% N as farmyard manure + 25% N as poultry manure + 25% N as oil seed cake). During January 2003, nitrogen was applied at 90g N tree^{-1} year^{-1} and was increased with an increment of 90g tree^{-1} each year. Basal doses of phosphorus and potash were applied in dormant season before bud sprout. The experiments were laid out according to RCB design and there were two trees per treatments with four replications. All the culture practices such as hoeing, weeding, irrigation were followed to keep the orchard in good condition. Leaf samples were collected in mid summer from mid portion of current year extension growth for nitrogen analysis. Data on pruned product, number of branches and height of the branches was recorded in dormant season (each year in December). The results showed that maximum number of branches, pruned products, height of branches and nitrogen concentration was obtained in treatment receiving 75% mineral N and 25% N from farm yard manure followed by mineral N alone treatment. Increasing the proportion of nitrogen from organic source beyond 50 percent decreased the vegetative growth.

Introduction

Deciduous stone fruits such as apples, peach, plum and apricot are the major fruit crops of NWFP, Pakistan. However, greater interest among the farmers has been observed in apricot plantation during recent years. The total area under apricot in Pakistan is about 28.8 thousand hectares with production of 210.9 thousand tons (MINFAL, 2004). The area is increasing, while per acre production is decreasing in spite of the best climate. The reasons for poor production and early decline of the orchard may be several but improper and imbalanced nutrients may be one of the important causes (Khan *et al*., 1983). In order to overcome these problems systematic work was initiated at this Institute in the recent past. Several leaf samples were collected from deciduous fruit orchards from Peshawar valley and analyzed for macro and micronutrients. About 80 percent fruit orchards were deficient in nitrogen (Shah *et al*., 1994; Mohammad *et al*., 1995). Nitrogen plays a major role in improving tree vigour, fruit bud formation and fruit set. The deficiency of nitrogen will result in small-sized and inferior quality fruit due to reduction in normal and functional leaf surface (Khan *et al*., 1983).

Use of mineral fertilizer is the quickest way of increasing crop production, their ever increasing demand in Pakistan coupled with unprecedented price hike and their availability at proper time deter the farmers from using them in recommended quantities and balanced proportion. Using higher proportion of nitrogen along with improved varieties, the resulting higher yield also remove ever larger amount of soil nutrient if not replenished will reduce fertilizer use efficiency and will resulting in stagnating and even declining the yield. The higher use of mineral N alone has accelerated the mining/removal of other essential nutrient to such an extent that the N use efficiency has dropped considerably. The organic sources, though bulky in nature and with low nutrient content, have the property of improving soil physical and microbiological condition, and thus enhance fertilizer use efficiency when applied in conjunction with mineral fertilizer (Lampe, 2000).

Keeping in view the usefulness and specific benefits of mineral fertilizers and organic manure for crops and soil, the ideas of integrated use of plant nutrient from various sources is being promoted. The integrated use of chemical, organic and bio-fertilizers not only involves low to medium inputs but also maintains the soil fertility and crop

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productivity. The use of organic along with low amount of chemical fertilizers results into higher crop yield than chemical fertilizer alone (Tandon, 1998; Lampe, 2000).

The current IPNS status in orchard revealed that 21.4% of the farmers in Pakistan are using mineral fertilizer combined with manure while only 10% are using manure (NFDC, 1998). In NWFP no systemic work has been conducted on the nutritional aspect of apricot fruit orchards. Keeping in view the importance of apricot orchard a long term field experiment was conducted with objective to improve vegetative growth and vigor of apricot orchard. The integrated plant nutrient management of mineral N would be the most desirable practice in the deciduous apricot fruit orchard which will reduce N loss from soil, prevent the nutrient mining from soil and sustaining crop yield and respecting the environment and in turn will improve the economic status of the farming community.

Materials and methods

A long-term field experiment on young apricot orchard was conducted at the experimental farm of Nuclear Institute for Food and Agriculture, Peshawar, to study the effect of nitrogen (applied alone as mineral fertilizer and in integration with various organic manures) on vegetative growth of a non-bearing young apricot orchard. The soil of experimental site at the institute was clay loam having pH 8.1, calcium carbonate 15%, organic matter 0.9%, total nitrogen 0.56%, Olsen P 7.3 mg kg^{-1}, potash 140 mg kg^{-1}, field capacity 0.37 cm^3 cm^{-3} and bulk density 1.62 g m^{-3}. The trees were planted with a row-to-row and plant-to-plant distance 6.5 m in January 2002. After establishment of the tree plants the first experimental treatments were imposed during January 2003. The nitrogen fertilizers were applied at 90 g N $tree^{-1}$ $year^{-1}$ and were increased with an increment of 90 g $plant^{-1}$ each year. In the first year 90 g N $tree^{-1}$, in the second year 180 g N $tree^{-1}$ and in third year 360 g $tree^{-1}$. All the mineral fertilizers and organic manure were applied before bud sprout in the first week of January each year as given in Table 1.

Table 1. Treatments

Treatment No.	Mineral fertilizer	Farmyard manure	Poultry manure	Oil seed cake
		% N from different sources		
T_1	0	0	0	0
T_2	100	0	0	0
T_3	75	25	0	0
T_4	50	25	25	-
T_5	25	50	25	-
T_6	25	25	25	25

A basal dose of P_20_5 as single superphosphate at 30 g $tree^{-1}$ $year^{-1}$ in 1st year, 60 g $tree^{-1}$ in 2nd year and 90 g $tree^{-1}$ in 3rd year was applied to all the treatments. All the treatments were replicated four times in a randomized complete block design with two plants per treatment making a total of 48 trees. For the control of trunk borer which caused gummosis (gum like substance exuding from the tree trunk) the plants were white washed on their trunk and branches with Bordeaux paste. Other cultural practices such as ploughing irrigation, weeding and annual pruning etc (young deciduous tree plants are pruned in order to develop a well balanced tree with a strong skeleton) were carried out as and when required. The leaf samples were collected from the mid portion of the current year extension growth during mid summer each year and analyzed for total nitrogen in order to know the nitrogen status of orchards. Every year during the dormant season (January) the data regarding number of branches per plant, height of plant (terminal growth after last pruning) and weight of the pruned products were recorded.

Results

The data obtained on weight of pruned products, height of branches, numbers of branches per tree and nitrogen concentration in the leaves during 2003 to 2006 are presented in Tables 2-4. It is evident from the data that T_2 (100% mineral N), T_3 (75% mineral N +25%) FYM andT_4 (50% mineral N +25% N from FYM + 25% N from poultry manure) significantly improved the tree

Table 2. Influence of integrated nitrogen management on the vegetative growth of young non-bearing apricot orchard during 2003-2004.

Treatment No.	No. of branches/tree	Height of branch (cm)	Pruned product (kg tree$^{-1)}$	% N
T_1	5.41b	112.6c	1.18bc	1.68b
T_2	6.01a	133.8ab	2.14a	2.01a
T_3	6.51a	156.8a	1.75ab	2.010a
T_4	5.95a	130.1b	1.40b	1.83b
T_5	4.65c	103.2d	0.81c	1.90ab
T_6	5.75ab	132.8ab	0.1d	1.94ab

Table 3. Influence of integrated nitrogen management on the vegetative growth of young non-bearing apricot orchard during 2004-2005.

Treatment No.	No. of branches/tree	Height of branch (cm)	Pruned product (kg tree$^{-1)}$	% N
T_1	11.75c	167.6c	2.02b	1.56b
T_2	13.36b	171.6b	2.81a	1.89a
T_3	15.36a	186.1a	2.90a	1.94a
T_4	12.88b	173.9b	2.55ab	1.83a
T_5	9.12d	165.3c	1.69c	1.70ab
T_6	11.37c	174.16b	2.44ab	1.76ab

Table 4. Influence of integrated nitrogen management on the vegetative growth of young non-bearing apricot orchard during 2005-2006.

Treatment No.	No. of branches tree-^{1}	Height of branch (cm)	Pruned product (kg tree$^{-1)}$	% N
T_1	13.75e	212.33c	4.97bc	1.69b
T_2	16.25a	214.18c	5.61b	2.04a
T_3	16.12a	225.70a	6.57a	2.00a
T_4	15.75b	219.47b	6.4a	2.05a
T_5	12.37d	216.496bc	3.92c	1.91ab
T_6	14.75bc	225.64a	5.71b	1.95ab

vigor and vegetative growth but the highest prune products, number of branches, hights of the branches and nitrogen content in the leaves were obtained in the treatment receiving 75% nitrogen from mineral fertilizer and 25% nitrogen from farm yard manure followed by treatment receiving all nitrogen from mineral fertilizer. In young orchard, pruned products reflect on current health, vigor and growth of a tree, which in turn depend on its nutritional status, and hence these products are indicative of efficiency of particular treatment. The branching of the young tree is an other important parameter for determining it's growth characteristics if the number of branches and hight of branches are more, fruit yield is likely to be higher and vice versa. In the present studies the number for branches were highest in treatment T3 followed by in treatment T2. Increasing the proportion of organic manure beyond 50% decreased the yield as compared to T_2, T_3 and T_4. The treatments receiving 25% mineral N combined with 25% organic manure from each source has also reduced the tree growth/performance.

Little work has been conducted on the integrated nitrogen management of deciduous apricot orchard. However, from these results it can be concluded that the best combination of nitrogen was when 75% of mineral fertilizer was combined with 25% N as farmyard manure.

Discussion

Nitrogen release from organic matter is influenced by many factors like source of organic manure, C: N ratio of the residue, lignin or phenol content of the residue, physical condition of soil especially aerobic and anaerobic condition, soil pH, soil management practices and environmental factors like moisture, temperature, drying, wetting, drying and freezing, and freezing and thawing (Alexander, 1961; Fox *et al*., 1990; William and Haynes, 1995). The beneficial effects of organic matter addition and decomposition to improve soil and plant nutrient availability especially N, have been reported (Goswami *et al*., 1986; Prasad and Power, 1992; Williams and Haynes, 1995). The combination of organic manure/organic matter with inorganic N in the integrated plant nutrition system (IPNS) provides the ideal condition for crop which improves soil properties and fertilizer N supply to plants (FAO, 1998).

The nitrogen derived from the organic N by mineralization is supplemented with fertilizer N and improves the N use efficiency and consequently improves the N uptakes by crop. In general, a major part of mineral N in this integrated approach is mobilized into biomass as organic N, which ultimately is remineralized slowly and gradually and remains available to crop over a long growing period and N losses during organic matter transformation (mobilization- immobilization processes or vice-versa) duo to leaching, volatilization and denitrification are minimized. The beneficial effects of integrated plant nutrition system especially the integrated use of minerals and organic fertilizers have been documented by NFDC (1998) and Tandon (1992). The beneficial effects of integrated use of organic and mineral fertilizers on crop production under the irrigated and non-irrigated conditions of Pakistan has been reported by Zada and Malik (1998), and Ibrahim *et al*. (2000).

Application of organic matter to soil as farmyard manure and poultry manure along with mineral fertilizers can arrest the decline in soil fertility that would accomplish intensive agriculture, substantially reduce the requirement of fertilizer and increase crop yields. The integrated nutrient supply and management through judicious use of fertilizer from the organic and inorganic sources will lead to sustainable high crops yields as well as help improve the fertilizer use efficiency and fertility of soil. The long-term use of this technology will be beneficial in achieving sustainable yields. It is, therefore, possible to shift the yield plateau to higher level with complementary use of organic matter than with mineral fertilizers alone. Hence, there is need for adopting integrated nutrient supply system for promoting efficient and balanced supply of nutrients, while the main emphasis has to be on increasing use of mineral fertilizer in the right direction; the role of organic manure, green manure and recycling of organic waste has to be supplementary and not substantive. The results obtained from this long-term study are indicative of certain benefits from integrating mineral and organic fertilizers for improved orchard productivity and sustenance of soil fertility. However, this type of studies needs extensive field demonstrations for adoption by the farming community.

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