Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; SP3: 110-113

Nagaveni HC
Assistant Professor (Contract), Department of Soil Science and Agricultural Chemistry, COH, Mudigere, Karnataka, India

Kumari
Assistant Professor (Contract), Department of Plant Pathology, COH, Mudigere, Karnataka, India

Chandana BC
Assistant Professor (Contract), Department of Crop Improvement and Biotechnology, COH, Mudigere, Karnataka, India

Suma AM
Senior M.Sc (Hort.), Departmnet of PSMAC, COH, Bengaluru, Karnataka, India

Correspondence
Nagaveni HC
Assistant Professor (Contract), Department of Soil Science and Agricultural Chemistry, COH, Mudigere, Karnataka, India

National conference on "Conservation, Cultivation and Utilization of medicinal and Aromatic plants"
(College of Horticulture, Mudigere Karnataka, 2018)

Effect of different nutrient levels on growth and yield of some medicinal plants

Nagaveni HC, Kumari, Chandana BC and Suma AM

Abstract
Plants have been one of the important sources of medicines ever since dawn of civilization. India is known as botanical garden of the world, with its vast bio-diversity and potential for commercial exploitation. Plant nutrition is the major factor which influences the growth and development of plant. Inadequate supply of plant nutrients is detrimental to plant growth and has a negative effect on the yield. Thus, the maximum yield can be obtained with optimum nutrient levels. The effect of nutrient elements at different level on the properties of medicinal plants was reviewed. Hence, the investigations carried out showed that effect of different levels of essential nutrients mainly macronutrients in the way of increasing the number of traits such as plant height, leaf area, yield seed, and oil content.

Keywords: nitrogen, phosphrous, potassium, leaves number, growth, yield

Introduction

Medicinal plants form a numerically large group of economically important plants which provide basic raw materials for medicines, perfumes, flavors and cosmetics. These plants and their products not only serve as valuable source of income for small holders and entrepreneurs but also help the country to earn valuable foreign exchange by way of export. It is estimated that, about 3000 plants were recognized in India for their medicinal value and of them, 200 species are in wide use for their curative properties. According to World Health Organization, the global market for plant based medicines will hit 5 trillion US dollar by 2030 (Anon., 2013) [5]. Medicinal plants are those plants which are rich in secondary -metabolites and arc potential source of drugs. This secondary metabolite includes alkaloids, glycosides, coumarins, flavonides, steroids etc. Drugs are derived from trees shrubs and herbs and even from primitive kinds of plants which are not even these. They are made from fruits (Senna, *S.viarum*, Datura etc.) flowers (*Buteamonos-perma*, *Bauhinia verigata*) leaves (Senna, Datura, Periwinkle, *Tylophora*etc.) stems (Liquorice, Ginger, Dioscorea, Costus, Garlic) roots (Rauvolfia, Periwinkle, Ginseng etc.), seeds (Isabgol, *Abrus*, Nuxvomica) and even bark (cinchona).

According to Government of India, Ministry of Agriculture, Department of Agriculture and Co-operation, New Delhi, Horticulture Statistics at a Glance, 2015 India consists of around an area of 499400 ha with a 925810 metric tons of production having productivity of 1.90 MT/ha and Karnataka consists of around an area of 3750 ha with a production of 7560 metric tons having 2.01 MT/ha productivity.

Plant nutrition is the major factor which influences the growth and development of plant. Inadequate supply of plant nutrients is detrimental to plant growth and has a negative effect on the yield. Thus, the maximum yield can be obtained with optimum nutrient levels. The seed treatment with bio-fertilizers also helps in getting good yield and quality. Plant nutrition is a term that takes into account the interrelationships of mineral elements in the soil or soilless solution as well as their role in plant growth. This interrelationship involves a complex balance of mineral elements essential and beneficial for optimum plant growth.

Nutrient deficiencies in plants are often made most evident by plant physiological responses. Nutrient deficiency symptoms tend to occur in three major patterns: localized to the younger tissues, localized to the more mature tissues, or widely distributed across the plant (Boroomand and Grouh, 2011) [15].

There are seventeen essential mineral nutrients are classified as macronutrients and micronutrients based on their plant requirements. There are nine macronutrients: Carbon (C),

Hydrogen (H), Oxygen (o), Nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S). The macronutrients, N, P, and K, are often classified as 'primary' macronutrients, because deficiencies of N, P and K are more common than the 'secondary' macronutrients, Ca, Mg, and S. The micronutrients include boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni) and zinc (Zn). Nitrogen is one of the most important nutrients needed by plants; it is an important element for the formation amino acids, it is essential for plant cell division, it is directly involved in photosynthesis, it is an important component of vitamins and it aids in the production of carbohydrates. Physiologically, N is mostly available to plants in the forms of ammonium and nitrate and preference for one of the two forms to be taken up by plants tend to be influenced by the plant species and soil conditions, including pH and soil temperatures. Fertilization programme in medicinal plants has two important objectives: high vegetative growth and high quantity and quality of secondary metabolites produced. Meeting these objectives could lead to high medicinal materials and increased medicinal value of a plant. Generally, N supply favour increased vegetative growth. Argyropoulou *et al.,* [6]

Phosphorus is found to be abundant in fruits and seeds of plants (Papadopoulos 1994) [36]. It is widely found that increasing P as a fertilizer will promote reproductive yields (Egle *et al.,*. 1999) [17] and inflorescence production (Besmer and Koide 1999) [13], particularly when P is limiting in natural systems (Feller 1995) [19]. Conversely, limitation of P supply has been shown to decrease the production of floral structures (Shamsi and Whitehead 1977) [42].

Potassium is the mineral nutrient required in the largest amount by plants. It is highly mobile within individual cells, within tissues and in long-distance transport via the xylem and phloem (Marschner, 1995) [30]. In contrast to the nutrients discussed above, potassium is not metabolized, and it forms only weak complexes, in which it is easily exchangeable. Next to the transport of carbohydrates and nitrogen compounds, potassium transport has been studied most intensely, using both physiological and molecular approaches.

Growth

Hossain *et al.,* (2007) [23] reported that N fertilizers increased the plant height of *Aloe vera*. Vetayasuporn, (2006) [44] reported significant increase in plant height of *Allium cepa* by P fertilizers.

Renata *et al.,* [40] 2012 and Kandil *et al.,* [27] 2009 concluded that, the application of nitrogen fertilization significantly differentiated mean height of basil plants, which decreased with the increase of this nutrient's dose and The applied nitrogen doses differently stimulated basil branching, and the greatest number of branchings (12.8 pcs per plant) was reported at medium and the highest nitrogen doses and also increased amount of NPK causes the increased number of basil branching.

Rahul *et al.,* 2016 [38] and Mastiholi (2008) [32] in coleus, reported that, there was a gradual increase in vine lengthwith increase in NPK doses. It is evident that when there is more availability of nutrients, crop puts up better vegetative growth with this Nagappa Desai and S. Thirumala in coleus concluded that plant height, number of branches were found to be more in plants applied with FYM along with Bio fertilizers. Further enhances the soil fertility status as biofertilizers like Azatobacter, Phosphorus solubilizing bacteria and Arbuscular Mychorriza fungi independently or in combination enhances the N and P status respectively.

Balashanmugam and Subramanian (1991) [10], Kamlesh Ahirwarwere reported that the highest N level up to N_{200} and K_{200} performed the best up to significant extent in case of plant height and number of leaves in turmeric. Aladakatti *et al.,*., 2012 [6] reported that The pooled data about stevia revealed that the increase in nitrogen levels from 200 kg ha^{-1} (N_1) to 400 kg ha^{-1} (N_3) increased the plant height, number of branches and leaves $plant^{-1}$ progressively. However, pooled data revealed that potassium level of K_2 (200 kg ha^{-1}) recorded the higher plant height (54.3 cm), more number of branches and leaves plant-1 (49.5 and 816.2 respectively). Vembu *et al.,* 2010 [43] and Hedge, 1988 reported that among various levels of NPK, the highest growth characters were recorded by the 40:50:50 kg NPK ha^{-l} in Catharanthus crop.

Abdissa *et al.,* (2011) [2] reported that P fertilizers had non-significanteffects on *Allium cepa* leaves number. Nori *et al.,* (2012) [35] also reported that N fertilizers had non-significant effects on *Allium sativum* leaves number.

Barandozi *et al.,* (2011) [12] observed increase in leaf length of *Aloe vera* under N and P fertilizers. Abdulsalam & Hamaiel (2004) [4], Abbas (2009) [1] were states that N and P fertilizers increased the leaf area of *Allium cepa* with increasing fertilizers doses observed significant effects of N and P fertilizers on leaf area of *Mentha spicata*. Hosenpor *et al.,* (2013) [22] observed that N fertilizers significantly increased the leaf area of *Calendula officinalis*. Sadashiv *et al.,* (2014) [41] observed that, the increased growth in coleus might be due to macro and micronutrients available in sufficient quantity in FYM and vermicompost and when applied with major nutrients might have helped in better growth of the crop.

The higher K accumulation in plant tissues at higher soil N doses can be explained in view of the fact that the response of K uptake by a crop depends to a large extent on its supply of NO_3^-N (Yoshida and Yoneyama, 1980) [46]. Furthermore, N and K are reported to have a synergistic effect to the regulation of plant growth (Mengel and Kirkby, 1987; Marschner, 1995) [33, 30]. Balky, 1998 [11], the enhancement of growth characters might be ascribed to the influence of nitrogen, which is the chief constituent of protein and an important component of amino acids and co. enzymes, which are of considerable biological importance.

Yield

The fresh and dry tuber yield was maximum in crops treated with organics combined with chemical fertilizers than the crop treated with organics alone. This increase in tuber yield might be due to the fact that vermicompost and FYM might have supplied higher amount of major and micronutrients this was confirmed by Sadashiv *et al.,* (2014) [41]. According to Rahul *et al.,* [38] the tuber yield followed the increasing trend with increase in nutrient dose up to a certain level (T_4: 15t FYM + 100: 50: 75 kg NPK per ha). Further increase in nutrient doses decreased the tuber yield. This may be due to more of vegetative growth and seed yield in increased nutrient doses which resulted in decrease in tuber yield.

Kamlesh Ahirwar reported that the applied nitrogen level up to N_{200} proved highly beneficial producing fresh turmeric rhizomes up to 102.41 q/ha, the applied potassium levels, the crop responded significantly up to the highest K level of K_{200}. At this K-level, the maximum rhizome yield was 99.28 q/ha and A combination of 200 kg/ha each of N and K recorded maximum rhizome yield (318.35 q/ha). According to Aladakatti *et al.,* 2012 [6] Higher stevia fresh biomass, fresh

leaf yield and dry leaf yield of stevia with higher N, P, and K nutrient levels could be attributed to more number of branches and leaves plant-1 of stevia due to higher plant height.

Allam *et al.*, 2001 [7] conducted research in Egypt showed a significant increase in dry leaf biomass yields of stevia when nitrogen fertilizer was increased from 10 to 30 kg N ha-1 wherein the dry leaves yield increased by 64 per cent compared to lower dose. Chalapathi *et al.*, 1999 [16] reported that growth and yield of stevia increased significantly with increasing rates of N, P and K up to 60:30:45 kg ha-1 per crop with the highest dry leaf yield which was on par with 40:20:30 kg ha-1 per crop in sandy loam soils at Bangalore

Ingle *et al.*, 2004 [24] reported that, the yield of safed musali tuber increased progressively with the increase in the levels of fertilizer up to 30:60:30 kg NPK/ha and the application of 20 t/ha + 30:45:30 kg NPK/ha combination recorded maximum 6.05 t/ha dry tuber yield of safed musali.

Vembu *et al.*,2010 [43] application of NPK @ 30:40:40 kg ha^{-1} recorded an increased root length of26.67 cm, fresh root weight of 22.82 g/plant and dry root weight of 8.46 g/plant at harvest. The control recorded the lowest fresh (15.82 g/plant) and dry (5.72 g/plant) weight of root. Ragunath (1981); Rajasekara *et al.*, (1982) [37, 39] also reported that application of NPK fertilizer increased the leaf and root yield of Periwinkle. Ishwar *et al.*, 1994 [25] confirm an earlier study in which a consistent increase in this yield component was observed in isabgol with increase in soil N level.

Ashraf *et al.*, 2006 [9] in isabgol A high level of N (90kgN/ha) proved to be detrimental to the growth and seed yield of isabgol. Although the optimum N level for this crop was 60 kg N/ha, in terms of cost-benefit ratio, 30 kg N/ha was a more suitable dose of N fertilizer from farmers' perspectives. Reduction in N applications also may have a positive impact on energy balance and environmental pollution. Among the various levels of major nutrients, application of 200, 100 and 100 kg N, P_2O_5 and K_2O/ha recorded the maximum plant height (109 cm), number of leaves (9.8/plant), length of leaf (62.8 cm), yield of green rhizome (0.53 g/plant) and (41 tonnes/ha).

Conclusion

Application of balanced level of essential nutrients to plants will increased the growth and yield of the crop. Combined application of N and P created favourable environment which increased uptake of nutrients from the soil for better growth and development. Synergistic effects of both N and P improved nutrient levels and enhanced plant growth by promoting the merismetic activity, which favour plant growth and finally higher seed, straw and biological yields.

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