Journal of Agroecology and Natural Resource Management
Print ISSN: 2394-0786, Online ISSN: 2394-0794, Volume 2, Number 2; April-June 2015 pp. 155-159

http://www.krishisanskriti.org/janrm.html

Seeding Density and Phosphorus Effects on Biomass, N Accumulation and Seed Production by Green Manure Crops–A Review

K. Sasikala[1] and P. Ashok[2]

[1,2]Horticultural College & Research Institute Dr Y S R Horticultural University, Venkataramannagudem, West Godavari, A.P
E-mail: [1]sasiagron@yahoo.in

Abstract—*Green manuring is one of the most effective and environmentally sound methods of sustaining soil productivity in Agriculture. The effectiveness of a green manure crop, however, is related to its ability to produce more biomass and to sequester large amount of plant nutrients in a short period of time. Therefore, any agronomic practice that enable the green manure crops to accumulate more biomass by the time they are turned in does help in improving the effectiveness of green manuring. Seeding density and phosphorus application going to effect the biomass, nutrient accumulation and seed production by green manure crops.*

Keywords*: Green manure crops, seeding density, P application, biomass, N accumulation and seed yield*

1. INTRODUCTION

Interest towards green manure crops has been renewed with the growing emphasis on sustaining soil productivity in Agricultural systems. Green manuring, a practice of turning the green plant biomass into the cultivated fields, is one of the most effective and environmentally sound methods of manuring crops, which offer an opportunity to improve soil physico-chemical environment and to cut down the use of chemical fertilizers, which are often blamed for causing environmental pollution and escalating cost of cultivation of crops.

The effectiveness of green manure crop is related to its biomass and nutrient accumulation by the time of flowering at which stage the crop biomass is turned into the fields. Biomass accumulation by green manure crops, however, is mostly affected by their seeding density and the soil fertility status especially phosphorus availability. Enhancement in phosphors supply to green manure crops, which are mostly of leguminous, may increase their ability to fix up more atmospheric nitrogen and result in better accumulation of biomass. Further, the availability of adequate amount of quality seed of green manure crops is a constraint to go for the practice of green manuring. The available literature on the effect of seeding density and phosphorus levels on biomass, N accumulation and seed production by green manure crops is reviewed hereunder.

2. GREEN MANURE CROPS AND THEIR BIOMASS PRODUCTION

On sandy loam soils of New Delhi, Chandnani and Oberoi (1956) recorded the highest green matter production by sunnhemp (*Crotalaria juncea*) than that by dhaincha (*Sesbania aculeate*). Similarly, on clay loam soils of Coimbatore, sunnhemp produced the highest biomass followed by dhaincha and pillipesara (*Vigna trilobus*) at 45-60 days after sowing during wet season (Abrol and Palaniappan, 1988). Bhardwaj (1982) reported maximum green matter yield by dhaincha at 65 days of growth on sandy loam soils of Palampur. Ghai *et al* (1985) reported that with increase in the age of dhaincha, there was a significant increase in biomass production up to 54 days after sowing and thereby started levelling off.

Research in India and elsewhere has shown that among all green manure crops, dhaincha and sunnhemp are the most predominant during pre monsoon season (Beri *et al*. 1989; Meelu *et al*., 1992). Halepyati and Sheelavantar (1991) recorded the highest dry matter with *Sesbania rostrata* and was followed by sunnhemp and dhaincha. They also reported the highest dry matter at the 8 th week cutting and the lowest at the 5 th week cutting during kharif on sandy loam soils of Dharwad. Such an increase in biomass with increase in age of the green manure crops (*S cannabina*, Sunnhemp, Soybean, *Lablab purpureus, Indigofera tinctoria*, pigeon pea, cowpea and mungbean*)* was also reported by Meelu *et al*. (1992) during kharif season. Sunnhemp produced the highest amount of dry matter followed by cowpea and dhaincha, which were almost at par, on sandy loam soils of Ludhiana, Punjab (Hundal *et al*., 1992). Between 50 and 70 days after establishment, the above ground biomass of *Sesbania speciosa* was doubled and the maximum was recorded at flowering stage (Weerakoon *et al*., 1992). Manandhar (1993) reported an

overall better performance of sunnhemp in the production of biomass than *Sesbania rostrata* and *Aeschynomene afraspera*. Sekhon *et al*. (1994) reported that the biomass of sunnhemp was higher than that of guar throughout the growth season on sandy loam soils of Ludhinana, Punjab. In contrary to the earlier reports, Hiremath and Patel (1994) recorded the highest biomass production by dhaincha than that by sunnhemp during kharif season at Navasari, Gujarat. Similar observations were made by Solaiappan *et al* (1996) on sandy loam soils of Madurai.

In the winter season, however, dhaincha and sunnhemp produced significantly higher biomass than that produced by *Sesbania rostrata* at 75 days after sowing (DAS) (Hiremath and Patel, 1996) and at harvest on clay soils of Navsari, Gujarat. Similar observations were made by Choudhary and Thakuria (1996) during winter season on clayey soils of Assam. Among the four green manure crops (dhaincha, *Sesbania rostrata*, *Indigofera tinctoria* and sunnhemp) sunnhemp reported to be the best suitable green manure crop due to its faster biomass production (Alam *et al*., 1997). Dhiancha recorded higher fresh biomass on the 40 th day, while *S rostrata* recorded that on the 60 th day after sowing at IARI, New Delhi (Kaliduri, 1998)

As noticed earlier, the season of growing green manure appears to be a prime factor to determine their productivity. Velvet beans produced the highest biomass production followed by sunnhemp in kharif season while rabi season was more favourable for pillipesara on clay loam soils of Coimbatore (Thomson and Palaniappan, 1998). Among the legumes, sunnhemp produced the highest green biomass followed by cowpea and dhaincha during rabi under intercropping situation on heavy black soils of Kovilpatti, Tamil Nadu (Solaniappan *et al*., 1999).

3. GREEN MANURE CROPS AND N ACCUMULATION

On sandy loam soils of Karnal, Bhardwaj (1982) reported, the highest N accumulation by dhaincha green manure crop at 65 DAS than at 45 or 55 DAS. N accumulation was higher with sunnhemp followed by dhaincha during kharif season on sandy loam soils of Dharwad (Halepyati and Sheelavantar, 1991). This was in confirmation with the result of Hiremath and Patel (1996). As the age of green manure crops increased, the N accumulation was also increased and the highest was recorded at the 8 th week cutting and the lowest was at the 5 th week cutting (Halepyati and Sheelavantar, 1991). Nitrogen accumulation in biomass of *Sesbania rostrata* was 2-3 times higher in wet season than that in dry season (Becker *et al*., 1995). Dhaincha accumulated the highest N followed by sunnhemp at 75 DAS on clayey soils of Navsari, Gujarat (Hiremath and Patel, 1994). Thomos and Palaniappan (1998) stated that velvet beans accumulated more nitrogen in 60 days compared to that of sunnhemp and pillipesara on clay loam soils of Coimbatore. *S rostrata* accumulated higher N during kharif season followed by summer and rabi seasons. Similar trend was observed in dhaincha and sunnhemp on clay loam soils of Tamil Nadu (Jayaram and Pannerselvam, 1999). Sunnhemp showed maximum nutrient accumulation when compared to that of dhaincha, berseem and cluster bean at Anand, Gujarat (Meisheri *et al*., 2001)

4. EFFECT OF SEEDING DENSITY ON BIOMASS PRODUCTION

4.1 Sunnhemp

Biomass production of sunnhemp found to increase with increasing seeding density, and reached the maximum at 100 kg ha^{-1} during winter season on vertisols of Navsari (Hiremath and Patel, 1996). Similarly, Thomos and Palaniappan (1998) reported maximum biomass production of sunnhemp at a higher poplation density of 1.67 lakh ha^{-1} than at lower densities, 1.11 or 0.83 lakh ha^{-1} on clay loam soils of Coimbatore.

4.2 Dhaincha

Seeding of *Sesbania rostrata* @ 60 kg ha^{-1} resulted in maximum biomass compared to that at lower seeding rates of 20 and 40 kg ha^{-1} (Padre and Ladha, 1990). In case of *S rostrata*, high population density (6.67 lakh plants ha^{-1}) produced the highest dry matter followed by medim (4.44 lakh plants ha^{-1}) and low densities (3.33 lakh plants ha^{-1}) on clay loam soils of Dharwad (Halepyati and Sheelavantar, 1991). Similar increase in dry matter production of *S speciosa* with increased planting density was reported by Weerakoon et al (1992) in Srilanka. On clayey soils of Navsari, Gujarat, seeding of dhaincha @ 100 kg ha^{-1} resulted in the maximum biomass compared to that at lower seeding densities rates of 50 and 75 kg ha^{-1} during winter season (Hiremath and Patel 1996). *S rostrata* planted at 15 cm intra row spacing recorded higher biomass than the other intra row spacings (30, 45 and 60 cm) on sandy clay loam soils of Tamil Nadu (Grace *et al*., 1998). Significantly higher biomass of Sesbania sps. was recorded under 60x15 cm spacing than under 90x15 cm and 120x15 cm spacing during kharif and summer seasons on deep clay loam soils of Coimbatore (Rengalakshmi and Purshothaman, 1999). Vendan and Rajeswari (1999) stated that biomass production of Sesbania sps. increased with increasing sowing rate and the highest was recorded at 50 kg seed ha^{-1} by broadcasting.

4.3 Pillipesara

The population of 1.67 lakh plans ha^{-1} recorded more biomass than that of 1.11 or 0.83 lakh plants ha^{-1} in kharif and rabi seasons on clay loam soils of Coimbatore (Thomos and Palaniappan, 1998)

5. EFFECT OF SEEDING DENSITY ON NUTRIENT ACCUMULATION

High density population (6.67 lakh plants ha^{-1}) in *S rostrata* recorded the highest nutrient accumulation followed by medium (4.44 lakh plants ha^{-1}) and low (3.33 lakh plants ha^{-1}) plant densities (Halepyati and Sheelavantar, 1991). With increase in seeding rate, the N accumulation was significantly increased and the highest was recorded at 100 kg seed ha^{-1} than at 50 and 70 kg seed ha^{-1} in sunnhemp and dhaincha during winter season on clayey soils of Navsari (Hiremath and Patel, 1996). Padre and Ladha (1990) also reported similar increase in N accumulation during winter season. Thomos and palaniappan (1998) reported higher N accumulation by velvet beans, sunnhemp and pillipesara green manure crops under high density (1.67 lakh plants ha^{-1}) followed by medium (1.11) and low (0.83 lakh plants ha^{-1}) densities on clay loam soils of Coimbatore.

6. EFFECT OF PHOSPHORUS ON BIOMASS PRODUCTION

6.1 Sunnhemp

Chandnani and Oberoi (1956) noticed an increase in green matter yield of various legumes with the application of phosphorus. Results from several studies have shown increased biomass of green manure crops with P application (Beri and Meelu, 1981; Sharma and Mittra, 1988; Herrera *et al*., 1989). Application of 50 kg P_2O_5 ha^{-1} favourably and significantly influenced dry matter production over no application, while the 50 and 75 kg P_2O_5 ha^{-1} were found to be at par in production of dry matter (Salgado *et al*., 1984). These results were in confirmation with those of Bodke and Shelke (1996). Enhancing the level of P application to 50 kg P_2O_5 ha^{-1} significantly increased fresh biomass of sunnhemp at all stages of growth in both kharif and rabi seasons on clay loam soils of Coimbatore (Thomos and Palaniappan, 1998). Pattanayak *et al.* (2001) observed similar increase in biomass of sunnhemp with the application of phosphorus through various phosphors sources during kharif season on sandy loam soils of Bhabaneswar.

6.2 Dhaincha

Singh (1972) reported that dry weight of *Sesbania cannabina* increased significantly with the application of 67.4 kg P_2O_5 ha^{-1} and it was at par with that of 101.1 kg P_2O_5 ha^{-1} on sandy loam soils of Varanasi. Becker *et al*. (1991) reported maximum growth, nodulation and nitrogen fixation in *Sesbania rostrata* with the application of mineral fertilizers. Application of phosphorus @ 150 kg P_2O_5 ha^{-1} significantly increased the dry matter at all stages over control in *S rostrata* during kharif season on clay loam soils of Dharwad, Karnataka (Halepyati and Sheelavantar, 1992). Hundal *et al*. (1992) reported that graded levels of phosphors up to 26 kg P ha^{-1} increased significantly the dry matter yield of dhaincha on sandy loam soils of Punjab. Fertilizer P application at seeding significantly increased the total dry matter yield at all stages of growth in *S rostrata* (Herrera *et al*., 1997). Pandher *et al* (1997) stated that the phosphorus application @ 64 kg P_2O_5 ha^{-1} significantly enhanced biomass production in dhaincha. A combination of basal application of super phosphate and foliar spraying of 2 per cent diammonium phosphate increased the dry matter production of dhaincha during kharif season on sandyloam soils of Kumulur (Kavimani *etal*., 1997)

6.3 Pillipesara

Enhancing the level of P application to 50 kg P_2O_5 ha^{-1} significantly increased the biomass in pillipesara at all stages of growth on clay loam soils of Coimbatore (Thomos and Palaniappan, 1998).

7. EFFECT OF PHOSPHORUS ON N ACCUMULATION

Chandnani and Oberoi (1956) reported that the application of phosphate to different legumes has helped to increase all the three major nutrients (N,P,K) in the crop over no application. Higher nitrogen accumulation and phosphors uptake due to phosphorus application were also observed by Balasubramani and Kannaiyan (1991). Application of phosphorus @ 150 kg P_2O_5 ha^{-1} increased N accumulation by *S rostrata* during kharif season on clay loam soils of Dharwad. Graded levels of P application up to 26 kg P ha^{-1} to green manure crops increased significantly the P content and P up take on sandy clay loam soils of Punjab (Hundal *et al*., 1992). Hiremath and Patel (1994) recorded maximum N accumulation with the application of 25 kg N+ 50 kg P_2O_5 ha^{-1} by dhaincha green manure crop on clayey soils of Navsari, Gujarat. Herrera *et al*. (1997) reported that nutrient accumulation by *S rostrata* increased significantly with increasing seed rate only when P was applied. Enhancing the level of P application p to 50 kg P_2O_5 ha^{-1} significantly increased N accumulation at all stages of growth in all the three crops (velvet beans, sunnhemp and pillipesara) on clay loam soils of Coimbatore (Thomos and Palaniappan, 1998)

8. SEED PRODUCTION BY GREEN MANURE CROPS

Production of seed by sunnhemp was found to be higher in rabi season than in kharif season. Thomos and Palaniappan (1998) reported the highest seed yield by velvet beans followed by sunnhemp and pillipesaaa on clay loam soils of Coimbatore. In Tamil Nadu, summer season was found ideal for seed production of Sesbania sp (Rengalakshmai and Purshothaman, 1999).

9. EFFECT OF SEEDING DENSITY ON SEED PRODUCTION

The seed rates of 20 and 30 kg ha^{-1} were at par and both were found significantly superior to 10 kg ha^{-1} seed rate in producing seed yield of sunnhemp during kharif season on

clay loam soils of Akola (Deshmukh et al., 1997). Thomos and Planaiappan (1998) reported the highest seed yield at lower density (60x20 cm) followed by medium (45x20 cm) and higher densities (30x20 cm). Increased seed yield of dhaincha green manure crop was obtained with wider spacing (45x20 cm) than that with narrower spacing (30x30 cm) during kharif on sandy clay loam soils of Kumulur (Kavimani *et al*., 1997). Similar increase in seed yield of Sesbania species with wider plant spacing (120x15 cm) than with the narrower plant spacings (60x15 cm and 90x15 cm) during kharif and summer season on deep clay loam soils of Tamil Nadu was reported by Rengalakshmi and Purshothaman (1999). Sowing of pillipeasa at 45 cm spacing gave the maximum seed yield which was 95 per cent and 18.1 per cent higher than that at 30 and 60 cm row spacings, respectively (Yadav, 1998). The reduction in seed yield of legumes with increase in planting density was reported by a few other researchers (Akinola and Whiteman, 1975).

10. EFFECT OF PHOSPHORUS ON SEED PRODUCTION

The influence of P on seed yield of green manure crops was well documented by Singh (1972). The increase in seed yield of sunnhemp under high fertility level was reported by Mohan (1973) and Iruthyaraj *et al*. (1979). Application of P @ 25 and 50 kg P_2O_5 ha^{-1} proved superior to no P application in producing seed yield, however, 50 and 75 kg ha^{-1} were found to be at par in sunnhemp (Salgado *et al*., 1984). At Varanasi, Singh (1972) reported significant increase in seed yield of dhaincha up to 67.4 kg P_2O_5 ha^{-1} during rainy season. Rengalakshmi and Purshothaman (1999) reported an increase in seed yield of Sesbania species with phosphorus application (50 kg ha^{-1}) than without on deep clay loam soils of Coimbatore. Application of P @ 40 kg P_2O_5 ha^{-1} significantly increased the grain yield of pillipesara over that of 20 and 30 kg P_2O_5 ha^{-1}. Bhati *et al*. (1988) reported significant increase in yield of pillipesara with the application of 40 kg P_2O_5 ha^{-1} and decreased with 60 kg P_2O_5 ha^{-1}. Seed yield of pillipesara significantly increased with increasing level of P application rates from no application of P to 40 kg P_2O_5 ha^{-1} (Sain and Keshwa, 1997).

REFERENCES

[1] Abrol I P And Palaniappan S P 1988. Green manure crops in irrigated and rainfed lowland rice based cropping systems in South Asia. Proceedings of Symposim on Sustainable Agriculture. Te role of green manure crops in rice farming systems. IRRI, Philippines 71-82pp

[2] Akinola J O and Whiteman P C 1975. Agronomic studies on Pigeon pea II/ Response to sowing density. Australian Journal of Agricultural Research 26: 57-66.

[3] Alam F, Majid M A and Islam M J 1997. Improvement of soil and substitution of nitrogen with green manure crops on followp sugarcane. Indian Journal of Agricultural Sciences 67: 455-458.

[4] Balasubramanian and Kannaiyan S 1991. Effect of phosphorus on nodulation and biomass production of *Sesbania rostrata*. Net Watch January-July, 1991, 2 pp.

[5] Becker M Ali M Ladha J K and Ottow J C G 1995. Agronomic and economic evaluation of *Sesbania rostrata* green manure establishment in irrigated rice. Field crop research 40 : 135-141.

[6] Becker M Diekmann K H, Ladha J K , De Datta S K and Ottow J C G 1991. Effect of NPK on growth and nitrogen fixation of *Sesbania rostrata* as a green manure crop for low land rice. Plant and Soil 132: 149-158.

[7] Beri V and Meelu O P 1981. Substitution of nitrogen through green manure in Rice. Indian Farming 31:3-4

[8] Beri V, Meelu O P and Khind C S 1989. Biomass production, N accumulation, symbiotic effectiveness and mineralization of green manures in relation to yield of wet and rice. Tropical Agriculture 66:11-16

[9] Bhardwaj K K R 1982. Effect of the age and decomposition period of dhaincha on the yield of rice. Indian Journal of Agronomy 27: 284-285.

[10] Bhati D S, Mathur J R and Sharma R C 1988. Response of moth bean to graded levels of N and P. Annals of Arid zone 27: 63-64

[11] Chandnani J J and Oberoi S R 1956 Studies on the relative value of various legumes as s source of green manure. Indian journal of Agronomy 1:95-103

[12] Chodhary J K and Thakuria R K 1996 Effect of green manuring on transplanted rice. Indian journal of Agronomy 41: 151-153

[13]

[14] Deshmkh, Giri D G , Dukare S R, Thakur V R and Giri M D 1997. Effect of seed rates, spacing and fertility levels on yield of sunnhemp. Annals of Plant physiology 11: 165-169.

[15] Ghai S K, Rao D L N and Batro L 1985. Comparative study of the potential of Sesbania for green manuring. Tropical Agriculture 62: 52-56.

[16] Grace T M, Ganesrajan V, Venkatachalapathy V and Chadramala M S 1998. Inter cropping of *Sesbania rostrata* in rice. Journal of Maharashtra Agricultural university 23: 261-264.

[17] Halepyati and Sheelavantar M N 1991. Growth analysis of *Sesbania rostrata* influenced by seeding densities and phosphors levels. Indian Agriculture 35: 63-65.

[18] Halepyati and Sheelavantar M N 1992 Effect of plant density and phosphors level on *Sesbania rostrata*. Indian Journal of Agronomy 37: 624-625.

[19] Herrera w T , Garrity D P, Vejpas C and Thongpan N 1989 Paper presented at the IRRI Saturday Seminar, April 15.

[20] Hiremath and Patel Z M 1994 Studies on the growth and N accumulation of various green manure crops under different fertility levels. Gujarath Agricultural University Research Journal 20: 137-138

[21] Hiremath and patel Z G 1996 Influence of seeding date and level of green manures during winter season on performance of summer rice. Indian Journal of Agronomy 41: 149-151.

[22] Hundal H S, Dhillon N S and Dev G 1992 Contribution of different green manures to P nutrition of Rice Journal of Indian Society of Soil Science 40: 76-81

[23] Jayaram and Pannerselvam P 1999 Seasonal influences of biomass productivity of certain green manures. Madras Agricultural Journal 86: 264-266

[24] Kalidurai M 1998 Nitrogen fixation and mineralization of *Sesbania rostrata* in rice soil ecosystem. Annals of Agricultural Research 19: 365-369

[25] Kavimani R, Arokiaraj A and Anndurai K 1997 Plant geometry and P management on the seed yield of dhaincha green manure. Madras Agricultural Journal 84: 627.
[26] Lawn and Troedson 1990. Pigeonpea: Physiology of yield formation. In . The Pigeonpea Cambridge 179-208 pp.
[27] Malewar P G 1993. Effect of sowing dates and inter row spacing on seed yield of sunnhemp in kharif season. MSc thesis submitted for the award of degree of MSc (Ag.) Marathwada Agricultural University, Parbhani.
[28] Manandhra R 1993. Biomasss and Nitrogen accumulation of three green manure crops as affected by soil moisture, seed rate and duration of cultivation, Bangkok, Thailand.
[29] Meelu O P, Morris R A, Furoc R E and Dizon M A 1992. Grain yield responses in rice to eight tropical green manures. Tropical Agriculture 69:133-136
[30] Meisheri T, Usadadia V P, Vaidya A C and Patel J B 2001. Green manures. Indian Farming 50: 11-12
[31] Padre A T and Ladha J K 1990. Effect of planting method and optimum seeding rate on biomass production and N fixation in *Sesbania rostrata*. International Rice Research New letter 15: 15.
[32] Pandher MS, Sharma S R and Gupta R P 1997. Effect of phosphorus, molybdenum and cobalt on symbiotic parameter of four lines of *Sesbania aculeata*. Journal of Research, Punjab Agricultural University 32:413-417.
[33] Pattanayak S K, Mishra K N, Jena M K and Nayak R K 2001.Evalution of green manure crops fertilized with various phosphorus sources and their effect on subsequent rice crop. Journal of the Indian Society of Soil science 49: 285-291.
[34] Rengalakshmani R and Purshothaman S 1999. Effect of season, spacing and phosphorus on seed production *Sesbania* species. Madras Agricultural Journal 86: 232-235.
[35] Sain M K and Keshwa G L 1997 Economics of nitrogen, phosphorus and mixtalol on rainfed moth bean production. Agricultural Science Digest 17: 54-56.
[36] Salgado A L , Azzinin C T, Petinelli A and Veiga A A 1984 Application of NPK fertilizer and lime in the production of green herbage and seed in Crotalaria. Bragantia 43: 271-278.
[37] Sekhon N K , Aggarwal G C, Sidhu A S and Thind S S 1994. Standing crop biomass, productivity and growth analysis of four green manure crops under different irrigation regimes. Annals of Agricultural Research 15: 332-338.
[38] Sharma A R and Mittra B N 1988 Effect of green manuring and mineral fertilizer on growth and yield of crops in rice based cropping on acid lateritic soil. Journal of Agricultural Science 110:605-608.
[39] Singh R G 1972 Effect of phosphate and boron on growth, nodulation and seed yield of dhaincha. Indian Journal of Agricultural Science 42: 139-144.
[40] Solaiappan U, Krishnadoss D and Senthivel S 1999. Influence of legume bio-mulches on seed cotton yield and changes in physicochemical properties of soil in rainfed vertisol. Indian Journal of Agricultural Research 33-119-124.
[41] Solaiappan , Krishnan S M and Veerabadran V 1996. Effect of rainfed green manure crops on succeeding rice. Indian Journal of Agronomy 41 : 147-149.
[42] Solunke S S 1994. Effect of sowing dates and inter row spacing on seed yield of sunnhemp in kharif season. Thesis submitted to Marathwada Agricultural University for the award of MSc thesis degree.
[43] Thomas and Palaniappan 1998 Biomass production and nitrogen accumulation of velvet beans, sunnhemp ad pillipesara as influenced by plant density and phosphorus application. Madras Agricultural Journal 85: 268-272
[44] Vendan and Rajeswari 1999 Studies on the seed rate and method of sowing of two popular Sesbania species. Crop Research, Hisar 18: 307-310.
[45] Weerakoon, Seneviratne G, Ananda M De Silva and Seneviratne A M 1992. Evaluation of Sesbania species as a green manure for low land rice in the dry zone of SriLanka. Plant and Soil 145: 131-139.