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Effect of tree spacing and organic manures on various growth parameters of C*alendula officinalis* L under *Grewia optiva* based agro-forestry system

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ABSTRACT

The present investigation was carried out in the experimental farm of Department of Silviculture and Agroforestry, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, HP during 2010-2011. The study revealed that the maximum leaves and branch wood biomass were recorded in 3 m spacing. Growth parameters of *Calendula officinalis* were suppressed under the close spacing. Organic manures showed a remarkable effect on growth parameters of *C officinalis*. Among organic manure doses FYM @5.00 kg per plot was found to be the best which was closely followed by vermicompost (2.50 kg). Growth parameters were also found to be higher in open condition as compared to beneath tree canopy. However integrating winter annual flower crop with *Grewia optiva* offers an excellent opportunity for diversification and more income generation than the monoculture. It will also open new vistas for the research to evaluate the performance of flower crop under tree canopy.

Keywords: Biomass; *Calendula officinalis*; FYM, organic manure; spacing, vermicompost

INTRODUCTION

Agro-forestry, one of the important alternatives for diversification is gaining importance in agro-ecosystem for production and economic upliftment of the farmers. Moreover agro-forestry is a natural resource conserving rather than a resource depleting system. *Grewia optiva* is an important multipurpose tree of north-western Himalayas distributed throughout the sub-Himalayan tract found up to an altitude of 1,800 m (Brandis 1972). It is sparingly found in forest area and is mostly raised along agriculture fields and is heavily lopped for palatable fodder. It is very popular among the farmers of north-western Himalayas for feeding their productive cattle during the winter period when no other green fodder is available. Negi (1986) reported that some major fodder trees on which hill farmers fall upon

during the lean period are Biul (*Grewia optiva),* Khirak (*Celtis australis*), Kachnar (*Bauhinia variegata*), Shhtoot (*Morus alba*), Ban (*Quercus leucotricophora*), black locust (*Robinia pseudoacacia*) etc. Among these *G optiva* excels in overall nutritive value and high digestibility.

The agricultural components in agro-forestry system have already shown their great potential to meet the diverse needs of the farmers as well as the farm based industries. Apart from grains, pulses, medicinal and aromatic plants the floriculture with agro-forestry can play an important role in socio-economic transformation of marginal farmers of the country. Growing of flowers in agro-forestry will open new vistas for research and development.

Flower cultivation has been practiced in India since time immemorial but floriculture has blossomed into a viable business only in recent years. The increased growing of contemporary cut flowers like rose, gladiolus, tuberose, carnation, marigold etc has led to their use for bouquets and arrangements for gifts as well as decoration of both home and work place. A growing market as a result of improvement in the general level of well being in the country and increased affluence particularly among the middle class has led to transformation of the activity of flower growing into a burgeoning industry. Availability of diverse agro-climatic conditions in this large country facilitates production of all major flowers throughout the year in some part or the other and improved transportation facilities have increased the availability of flowers all over the country. The flower crop selected for the present study was *Calendula officinalis* L which is commonly known as Pot Marigold and belongs to the family Asteraceae. It is probably native to suthern Europe though its long history of cultivation makes its precise origin unknown and may possibly be of garden origin. It is also widely naturalized further in Europe and elsewhere in warm temperate regions of the world. *C officinalis* is widely cultivated in sunny locations and in different kinds of soils. It is grown for a drug calendulae floss obtained from the flowers particularly the petals (Bissett 1994). World trade of marigold flowers is estimated to be of ₹500 crores. China, India and Peru are the leading countries producing and exporting marigold flowers.

Organic farming comprises of diversified agriculture techniques like intercropping, crop rotation, green manuring, organic manures (FYM and compost), organic residues, biofertilizers etc; organic manures include farmyard manure, vermicompost, biofertilizers, green manures etc. In agro-forestry systems the use of organic manures is found to increase the efficiency because the leaves or small twigs fall directly on to the floor/ surface where crop is growing. Organic manure is

well suited to achieve both production and conservation goals. The cultivation of flower crop under *G optiva* tree could be an economically viable option with least expenses because of the use of organic manures. However successful cultivation of flower crop under agro-forestry requires information on species adaptability under shade, their cultivation, management and economic assessment of the system. The information on these aspects of *Grewia* based agro-forestry system involving flower crop and the use of organic manures is meager. There are still many unanswered questions which require great deal of research.

MATERIAL and METHODS

The experimental site was located at Nauni 30º51' N latitude and 76º1'E longitude with an elevation of 1,200 m amsl, 15 km south-east of Solan town and represents transitional zone between sub-tropical and sub-temperate zone of Himachal Pradesh . The climate of the study site is sub-tropical to sub-temperate. The area receives an annual rainfall of approximately 1,150 mm most of which is received during the month of July and August.

An agro-forestry system comprising of *Grewia optiva* + *Calendula officinalis* was developed to study the effect of different tree spacings and organic manures on growth, flower and seed production parameters of winter flower annual (*Calendula officinalis* L). The *G optiva* was planted at different spacings viz 1 m × 8 m, 2 m × 8 m and 3 m × 8 m apart. *C officinalis* an important winter annual flower was sown as intercrop and applied with four manure doses viz 2.50 kg and 5.00 kg FYM and 1.50 kg and 3.00 kg vermicompost per plot. Size of the plot was 90 × 180 cm. The experiment was planned using split plot design. Nursery raised seedlings of *C officinalis* were transplanted during the month of November 2010.

RESULTS and DISCUSSION

Effect of tree spacing on leaves and branch wood biomass production of *Grewia optiva* in agro-forestry system: The results of the present investigation indicate that height was significantly influenced by tree spacing and plant height increased with decrease in tree spacing except in Sp_1 (Table 1). Maximum (5.01m) tree height was recorded in the trees planted at 2 m apart (Sp_2). These results are in line with the findings of Singh et al (2004) who reported increase in plant height of *Acacia tortilis* with the decrease in plant spacing. Maximum crown spread (2.15 m^2) was recorded in Sp_3 whereas minimum (1.69 m^2) crown spread was recorded in Sp_1. Crown spread was influenced significantly by tree spacing. Maximum crown spread was recorded in widest spacing due to availability of more space to spread the crown as compared to the closer spacing.

The results of the present investigations (Table 1) reveal that among three spacings Sp_3 produced higher (4.00) number of main branches whereas lower (2.92) number of main branches was recorded in Sp_1. Maximum (115.25) number of sub-branches was recorded in Sp_3 while lower (41.08) number of sub-branches was recorded in Sp_1. Maximum branch wood biomass (19.86 kg/tree) was recorded in Sp_3 and minimum (13.29 kg/tree) was recorded in Sp_1. Maximum number of leaves per branch (317.75) was recorded in Sp_3 and the minimum (200.42) in Sp_1. Maximum fresh leaves biomass/tree (6.37 kg/tree) was recorded in Sp_3 whereas minimum (4.57 kg/tree) was recorded in Sp_1. The number of main and sub-branches was also significantly affected by tree spacing. The number of branches was more in wider spacings to trap more sunlight for the process of photosynthesis. It is also responsible for the production of more leaves in the tree which ultimately produces the higher biomass of leaves and branches. Thus wider spacing ie 3 m × 8 m was found to be the best for the production of higher biomass due to its higher crown spreads. The results of the present findings can be endorsed with the findings of Hongtong (1990) who reported that increasing spacing would also increase biomass of branches, leaves and main roots of trees.

Effect of tree spacing and organic manures on various growth parameters of *Calendula officinalis* L under *Grewia optiva* based agro-forestry system: Various growth parameters viz plant height, number of primary shoots, number of secondary shoots, number of tertiary shoots and plant spread were recorded and the data are presented in Tables 2 and 3.

The growth parameters of *C officinalis* were significantly influenced by the tree spacing and use of organic manures (Table 2). Maximum plant height (49.85 cm) was recorded in Sp_0 whereas minimum (45.25 cm) was recorded in Sp_1. On the other hand application of organic manures significantly influenced the plant height of *C officinalis*. It was recorded maximum (48.77 cm) in T_1 (5 kg FYM) and minimum (45.98 cm) in T_5 (control). Cumulative effect of treatments and spacing (S × T) was also found to be significant. Maximum plant height (51.06 cm) was recorded in Sp_0T_1 whereas minimum (42.88 cm) in Sp_1T_4. The closer spacing of *G optiva* was found to be suppressing the growth parameters but with the increase in tree spacing *C officinalis* exhibited superior growth parameters. This may be due to the shade effect of *G optiva* crown and intraspecific competition between two components of the system. The negative effect in close vicinity of trees can be ascribed to more competition for light which is also evident from the present study. These results are in line with the findings of Chauhan et al (2009) where they reported that the less light in inter-cultivated wheat crop was due to the shade during the initial growth period. It is evident from the Table 2 that organic

manures like FYM increase the plant height of *C officinalis* as compared to the control. These results are in conformity with the findings of Prakash et al (2002) and Yadav et al (2000) where they reported that media consisting of red soil + FYM (1:1) was found to be the best in respect of plant height for marigold. Highest (23.30 cm^2) plant spread was recorded in open condition (Sp_0) whereas lowest (17.27 cm^2) in Sp_1 (Table2). Less plant spread of *C officinalis* plants under *G optiva* canopy than open may be due to competition for resources and modified micro-environmental conditions. The higher plant spread at wider tree spacing probably due to higher production of photosynthates and the productivity of under story is affected due to influenced physiological process. Miah et al (1999) recorded lower production of photosynthates under low light conditions for longer periods thus resulting in low plant growth. The results of present study are in line with the findings of Kaur et al (1995) who also reported widest plant spread along with the longest flowering duration.

The branches are the skeleton of the plant and the number of primary and tertiary shoots of *C officinalis* were significantly influenced by tree spacing and organic manures doses whereas secondary shoots were found to be not influenced due to the manure doses and were found to be significantly influenced by tree spacing. The content of data presented in Table 3 reflects that all tree spacing, organic manures and cumulative effect of treatments and spacing (S × T) influenced primary shoot production in *C officinalis* L. The maximum number of primary shoots (6.35) was recorded in treatment T_1 (FYM 5.00 kg) and the minimum number of primary shoots (5.73) was recorded in T_5 (control). While among spacing maximum number of primary shoots (6.39) was recorded in Sp_0 and the minimum (5.77) in Sp_2. Cumulative effect of spacings and application of organic manures reflects that treatment combination T_2Sp_0 recorded higher (7.15) number of primary shoots where it was recorded minimum (4.93) in T_5Sp_2. A perusal of the data presented in Table 3 reveal that different spacing had a significant effect on secondary shoots production. It was recorded maximum (16.02) in Sp_0, and minimum (11.56) number of secondary shoots was recorded in Sp_2. Treatments and cumulative effect of treatments and spacing (S×T) registered a non-significant value. Among four spacings maximum (6.61) number of tertiary shoots was recorded in Sp_3 which was found to be statistically at par with Sp_0. On the other hand Sp_1 registered minimum number of tertiary shoots (4.46). Treatments effect reveals that maximum number of tertiary shoots (6.21) was found in T_1 which was found to be statistically at par with the T_2, T_3 and T_4 and minimum (4.90) was recorded in T_5 (control). Cumulative effect of treatments and spacing (S × T) reveals that treatments combination T_3Sp_3 recorded higher (8.56) number of tertiary shoots and

Table 1. Effect of tree spacing on leaves and branch wood biomass production of *Grewia optiva* in agro-forestry system

Tree Spacing	Tree height (m)	Crown spread (m^2)	Number of main branches/tree	Number of sub branches/tree	Number of leaves/ branch	Leaf biomass/ tree (kg/tree)	Branch wood biomass/ tree (kg/tree)
Sp_1	4.33	1.69	2.92	41.08	200.42	4.57	13.29
Sp_2	5.01	2.03	3.25	75.5	259.58	5.03	16.82
Sp_3	4.81	2.15	4.00	115.25	317.75	6.37	19.86
$CD_{0.05}$	0.45	0.32	0.84	16.81	38.07	0.31	0.34

Sp_1= 1m, Sp_2= 2m, Sp_3= 3m

Table 2. Effect of tree spacing and organic manures on various growth, parameters of *Calendula officinalis* L under *Grewia optiva* based agro-forestry system

	Plant height (cm)					Plant Spread (cm^2)				
	Sp_1	Sp_2	Sp_3	Sp_0	mean	Sp_1	Sp_2	Sp_3	Sp_0	Mean
T_1	48.38	48.90	47.27	50.51	48.77	19.88	18.36	19.20	23.14	20.14
T_2	44.27	46.96	48.68	50.33	47.56	17.94	17.29	19.82	21.84	19.22
T_3	44.50	46.67	47.7	49.88	47.19	16.89	18.42	18.67	23.44	19.36
T_4	42.88	45.79	46.23	51.06	46.49	16.02	18.25	18.38	23.76	19.10
T_5	46.25	44.45	45.76	47.48	45.98	15.65	18.11	18.24	24.30	19.08
Mean	45.25	46.55	47.13	49.85		17.27	18.09	18.86	23.30	
$CD_{0.05}$	S= 1.95, T= 1.20, S x T= 2.41					$CD_{0.05}$	S= 0.86,	T= NS,	S x T= NS	

Sp_1= 1 m, Sp_2= 2 m, Sp_3= 3 m, Sp_0= Open condition
T_1= 5.00 kg FYM, T_2= 3.00 kg FYM, T_3= 2.50 kg VC T_4= 1.50 kg VC T_5= Control
FYM= Farm Yard Manure, VC= Vermicompost

Table 3. Effect of tree spacing and organic manures on various growth parameters of *Calendula officinalis* L under *Grewia optiva* based agro-forestry system

	# of primary shoots					# of secondary shoots					# of tertiary shoots				
	Sp_1	Sp_2	Sp_3	Sp_0	Mean	Sp_1	Sp_2	Sp_3	Sp_0	Mean	Sp_1	Sp_2	Sp_3	Sp_0	Mean
T_1	6.78	6.26	6.41	5.96	6.35	16.37	13.04	11.78	16.67	14.46	5.56	6.56	6.00	6.74	6.21
T_2	6.67	5.85	5.33	7.15	6.25	12.33	10.81	14.22	15.41	13.19	4.19	5.44	6.89	6.52	5.76
T_3	5.70	6.48	6.00	5.96	6.04	10.22	11.59	16.04	16.70	13.64	3.52	5.04	8.56	6.74	5.96
T_4	5.85	5.33	6.63	6.00	5.95	11.85	11.78	12.15	15.37	12.79	3.96	4.96	6.00	6.56	5.37
T_5	5.44	4.93	5.70	6.85	5.73	11.63	10.59	10.93	15.96	12.28	5.07	4.59	5.59	4.33	4.90
Mean	6.09	5.77	6.01	6.39		12.48	11.56	13.02	16.02		4.46	5.32	6.61	6.18	
$CD_{0.05}$: S= 0.41, T= 0.47, S × T= 0.94						$CD_{0.05}$: S= 1.54, T= NS, S × T= NS					$CD_{0.05}$: S= 1.07, T= 0.85, S × T= 1.70				

Sp_1= 1 m, Sp_2= 2 m, Sp_3= 3 m, Sp_0= Open condition

T_1= 5.00 kg FYM, T_2= 3.00 kg FYM, T_3= 2.50 kg VC, T_4= 1.50 kg VC, T_5= Control

FYM= Farm Yard Manure, VC= Vermicompost

it was found to be statistically at par with the treatment combination T_2Sp_3 whereas treatment combination T_3Sp_1 recorded lesser (3.52) number of tertiary shoots. Treatment effect reveals that higher number of primary and tertiary shoots (Table 3) was recorded in T_1 (FYM 5.00 kg) as compared to the control. This could be attributed to better flow of various micro- and macro-nutrients along with the plant growth substances into the plant system. Thereby it might have favored for stimulation and production of auxiliary buds resulting in formation of more number of branches. The above said results are also corroborated with the findings of Hari Priya and Sriramachandrasekharan (2002) in marigold.

CONCLUSION

The different growth parameters of *Grewia optiva* viz tree height, crown spread, number of branches, number of leaves per branch and leaves and branch wood biomass were recorded and the results reflect that wider spacing (Sp_3) ie 3 m spacing recorded higher growth parameters however tree height was recorded maximum in (Sp_2) ie 2 m spacing. Different growth parameters such as plant height, number of primary, secondary, tertiary shoots, and plant spread of *Calendula officinalis* were recorded. The results of the investigation reveal that these parameters are significantly influenced by *G optiva* spacing and application of organic manure. Although higher plant height of *C officinalis* was recorded in open condition but within the system *G optiva* planted at a spacing of 3 m (Sp_3) registered superiority over the other two spacing. Organic manures improved the growth parameters of *C officinalis* as compared to control (no manure). Among different doses of organic manures application of FYM @ 5.00 kg per plot and vermicompost @ 2.50 kg per plot was found to be the best doses for improving growth parameters of *C officinalis* under *Grewia*-based agro-forestry system.

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