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Comparison on nursery raising of winter season annuals

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Abstract

The study was conducted to standardize nursery-raising techniques for different sowing times of winter-season annuals and to compare traditional and improved planting. The winter season annuals namely *Calendula officinalis*, *Glebionis coronaria*, *Dimorphotheca sinuata*, *Helichrysum bracteatum*, *Dianthus barbatus*, *Delphinium ajacis*, *Arctotis grandis*, *Viola tricolor*, *Iberis umbellata*, *Lupinus hartwegii*, *Centaurea cyanus*, *Alyssum maritimum*, *Dorotheanthus bellidiformis*, *Godetia grandiflora*, *Papaver rhoeas*, *Clarkia elegans* and *Antirrhinum majus* were sown at 15-day intervals. The results revealed that between the two sowing methods- protrays and nursery beds, the winter season annuals raised in protrays performed better with respect to maximum germination percentage (95.00%) was recorded in *Papaver rhoeas* sown on 30th December, minimum number of days taken for seedling emergence was observed in *Lupinus hartwegii* (4.00days) sown on 15th October, maximum seedling length (16.63cm) was observed on seeds sown in 30th. Among the different winter season annuals *Lupinus hartwegii* (480.38) recorded the highest seedling vigour index II. A greater number of consumers (77.25%) preferred seedlings raised in protrays as compared to nursery beds (22.75%). *Lupinus hartwegii* (26.83 days) sown in nursery beds on 15th October took minimum numbers of days for harvesting of ready to sale seedlings.

Keywords: Seedling emergence, nursery beds, Protrays, root length, winter annuals

Introduction

Annuals are those plants that complete their entire life cycle from seed to flower and back to seed within a single growing season (Kashyap *et al.*, 2020) ^[6]. Annuals are the most versatile flowering plants in a garden. It has become a popular garden attraction because of the great range of annual blooms that are accessible in the winter. It is primarily grown in the northwestern plains, where the plant blooms in March–April and sets seed in April–May. More than ₹ 6-7 crores are reportedly exported each year from the Punjab state in the form of flower seeds to the United States, Holland, Germany, and the United Kingdom from an area of roughly 2000 acres (Anumala and Kumar, 2021) ^[2]. In a nationwide survey of growers and plant dealers conducted by Hodges *et al.* (2015) ^[5] in the United States reported that annual bedding or flowering annuals was the largest specific plant type sold with 17.6% of the total ornamental horticulture industry sales. Annual bedding and herbaceous perennial plants were estimated to have a combined wholesale value of \$ 2.16 billion in the Floriculture Crops 2018 Summary report (USDA NASS, 2019), making them the largest contributor of all plant categories and accounting for 47% of the total wholesale value of floriculture crops. Normally winter season annuals are grown through traditional method by raising seedlings in nursery beds and then transplant them in beds or pots. Protray was developed to produce high-quality seedlings for quick, effective transplanting. The production of flower seedlings as plugs has garnered more attention recently. This technology reduces the loss of expensive seeds, improves seed germination, promotes uniform growth, reduces seed mortality, and, at the same time, saves labour, time, and overall greenhouse space, while accommodating more crops per unit area. It promotes easier handling during transportation and transplanting with little to no transplanting shock. Keeping in view, the experiment was conducted with the following objectives to standardize nursery raising technique for different sowing time of winter season annuals and compare traditional and improved methods of planting.

Materials and Methods

The experiment was carried out at the Research Farm of the Department of Floriculture and Landscape Architecture, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan (H.P), during 2021-2022, with the objectives to standardize nursery raising technique for different sowing times of winter season annuals and to compare traditional and improved methods of planting. The study was conducted on seventeen winter season annuals where sowing was done at 15-day intervals following two sowing methods- protrays and nursery

beds. For nursery beds, recommended practices were followed. The seedlings sown in protray were composed of growing media, cocopeat, soil, and farmyard manure in the ratio 2:1:1. Once a week, fertilizer, i.e., NPK (19:19:19) was given @ 5g/l to seedlings. The experiment was laid out in a Completely Randomized Design (Factorial), with three replications. All nursery parameters were recorded.

Results and Discussion

Table 1: Effect of winter season, annual flower crops, nursery raising method and sowing dates on germination percentage (%)

Winter season annuals	Sowing method	Sowing dates							
		15th October	30th October	15th November	30th November	15th December	30th December	15th January	30th January
<i>Calendula officinalis</i>	Protray	47.00	45.00	64.00	54.00	36.67	72.33	75.33	43.33
	Nursery bed	57.00	52.67	31.00	39.00	35.67	56.00	30.67	50.00
<i>Glebionis coronaria</i>	Protray	14.33	13.00	8.67	7.33	8.33	9.00	7.67	12.33
	Nursery bed	7.67	8.67	7.67	6.00	10.00	7.67	9.67	9.00
<i>Dimorphotheca sinuate</i>	Protray	68.00	55.00	88.33	49.00	75.33	55.33	74.00	71.67
	Nursery bed	48.67	28.67	26.33	29.00	35.67	51.67	34.67	43.00
<i>Helichrysum bracteatum</i>	Protray	56.33	40.00	75.00	66.33	81.00	71.00	59.67	72.67
	Nursery bed	57.67	22.33	22.67	31.00	39.67	33.33	27.67	29.33
<i>Dianthus barbatus</i>	Protray	55.33	57.67	53.33	53.33	83.67	60.33	42.33	59.00
	Nursery bed	53.67	41.33	31.67	49.67	47.67	60.67	49.00	67.67
<i>Delphinium ajacis</i>	Protray	73.33	75.00	88.00	85.67	83.33	75.67	55.00	54.33
	Nursery bed	53.00	39.33	57.33	55.33	53.67	73.00	48.67	59.33
<i>Arctotis grandis</i>	Protray	26.67	60.67	89.67	41.67	79.33	51.00	49.67	78.00
	Nursery bed	37.33	25.67	8.33	9.33	21.00	34.00	39.67	21.67
<i>Viola tricolor</i>	Protray	68.33	59.00	71.00	81.00	69.33	64.67	57.00	88.67
	Nursery bed	10.00	47.00	29.00	47.67	35.00	55.00	15.33	51.67
<i>Iberis umbellata</i>	Protray	74.33	56.67	73.67	86.33	78.33	66.33	36.33	77.33
	Nursery bed	63.00	33.33	27.00	58.00	54.67	70.00	39.67	51.33
<i>Lupinus hartwegii</i>	Protray	66.33	76.67	83.67	76.67	84.00	53.33	67.33	71.33
	Nursery bed	67.00	59.67	35.67	57.33	50.67	68.67	37.67	59.00
<i>Centaurea cyanus</i>	Protray	61.67	59.33	78.67	44.33	79.00	57.67	67.33	72.33
	Nursery bed	61.00	19.67	41.33	12.67	56.33	47.00	58.33	53.67
<i>Alyssum maritimum</i>	Protray	56.33	66.33	77.67	81.33	94.00	82.33	71.67	71.00
	Nursery bed	70.00	52.67	38.33	26.33	46.67	20.67	44.67	48.00
<i>Dorotheanthus bellidiformis</i>	Protray	68.67	41.33	53.00	46.67	57.33	63.33	79.67	36.00
	Nursery bed	18.33	31.33	10.00	17.00	16.67	18.00	12.33	22.00
<i>Godetia grandiflora</i>	Protray	45.33	49.33	68.67	74.33	49.00	54.67	50.00	30.00
	Nursery bed	30.33	50.00	27.67	35.33	40.67	43.33	39.33	46.67
<i>Papaver rhoeas</i>	Protray	80.33	85.67	84.33	81.33	70.00	95.00	33.67	35.67
	Nursery bed	80.33	38.67	35.00	7.00	45.67	30.33	40.67	28.00
<i>Clarkia elegans</i>	Protray	31.67	40.00	78.33	86.00	87.67	80.33	70.67	57.33
	Nursery bed	57.67	36.67	33.00	22.67	45.67	44.00	51.33	58.67
<i>Antirrhinum majus</i>	Protray	16.33	11.00	8.33	11.00	33.00	56.33	61.00	64.67
	Nursery bed	9.33	9.33	8.00	9.00	11.33	9.67	8.67	10.00
CD _{0.05}		1.03							

The data pertaining to the effect of interaction between flower crops x nursery raising methods x sowing dates presented in Table 1 revealed that the maximum germination percentage (95.00%) was recorded in *Papaver rhoeas* sown on 30th December in protrays. In contrast, minimum germination percentage was recorded in *Glebionis coronaria* (6.00%) sown

in nursery beds on 30th November. This much wide variation may be due to genetic makeup of each winter annuals, seed size, seed coat as well as the environmental conditions Bungard (R A, et al. 1997) [3] and (Baweja, et al. 2001) [4], prevailing during the growing period and sowing method i.e., protrays and nursery beds.

Table 2: Effect of winter season annual flower crops, nursery raising methods and sowing dates on days taken for seedling emergence (day)

Flower crops	Sowing method	Sowing dates							
		15 th October	30 th October	15 th November	30 th November	15 th December	30 th December	15 th January	30 th January
<i>Alyssum maritimum</i>	Protray	7.50	7.33	7.83	9.50	10.00	9.67	11.33	10.67
	Nursery bed	10.00	9.83	9.67	11.67	12.67	12.83	14.00	13.67
<i>Antirrhinum majus</i>	Protray	16.83	18.67	17.83	18.67	19.00	19.00	19.50	19.50
	Nursery bed	23.50	24.17	24.50	24.50	25.17	26.33	26.50	26.33
<i>Arctotis grandis</i>	Protray	9.00	10.33	10.33	10.67	11.50	11.50	13.00	12.17
	Nursery bed	11.67	12.67	12.00	14.00	20.67	14.33	16.33	15.17
<i>Calendula officinalis</i>	Protray	5.50	7.33	6.17	8.00	9.33	9.00	9.50	9.33
	Nursery bed	7.50	9.00	8.67	9.83	12.33	11.83	13.00	13.50
<i>Centaurea cyanus</i>	Protray	6.17	6.67	5.83	7.67	9.00	8.83	9.83	9.50
	Nursery bed	8.50	9.17	8.67	10.83	12.00	11.83	12.50	13.00
<i>Clarkia elegans</i>	Protray	7.67	8.33	8.17	8.83	9.83	9.67	10.83	11.33
	Nursery bed	11.00	11.00	11.17	11.50	12.83	11.67	12.67	13.50
<i>Delphinium ajacis</i>	Protray	11.67	12.33	12.00	12.50	13.83	14.00	14.33	14.17
	Nursery bed	16.00	15.00	16.00	17.00	16.00	16.67	17.33	14.00
<i>Dianthus barbatus</i>	Protray	7.83	9.00	9.00	10.00	10.50	10.67	12.33	11.33
	Nursery bed	10.83	11.17	10.83	13.17	16.50	15.00	15.67	15.17
<i>Dimorphotheca sinuate</i>	Protray	5.00	6.67	6.83	7.17	8.67	8.17	9.33	9.33
	Nursery bed	6.50	7.83	9.83	11.00	11.33	11.67	12.50	13.33
<i>Dorotheanthus bellidiformis</i>	Protray	13.67	14.67	15.50	16.33	16.00	16.67	18.33	17.67
	Nursery bed	18.00	18.00	19.67	20.00	21.33	20.33	21.83	21.17
<i>Glebionis coronaria</i>	Protray	6.17	8.33	8.00	9.00	10.33	10.00	10.83	11.17
	Nursery bed	11.67	12.67	13.00	12.67	13.67	13.00	14.17	14.50
<i>Godetia grandiflora</i>	Protray	8.33	8.00	8.33	8.67	10.00	9.50	10.33	10.67
	Nursery bed	10.50	10.33	10.83	12.00	12.67	12.50	13.50	14.50
<i>Helichrysum bracteatum</i>	Protray	8.50	10.17	9.67	11.33	12.00	12.00	12.67	12.67
	Nursery bed	11.33	11.17	11.67	13.33	14.00	14.33	15.67	16.50
<i>Iberis umbellata</i>	Protray	7.33	10.67	9.83	10.83	11.33	12.00	12.50	12.33
	Nursery bed	10.83	12.33	11.50	12.67	13.17	15.33	16.33	15.17
<i>Lupinus hartwegii</i>	Protray	4.00	5.33	5.67	6.50	7.33	7.67	8.50	8.67
	Nursery bed	6.17	7.33	7.67	8.67	11.00	10.17	11.50	11.17
<i>Papaver rhoeas</i>	Protray	7.00	8.50	8.00	9.00	10.50	10.17	13.50	11.17
	Nursery bed	10.33	10.17	10.50	12.00	12.67	13.50	13.17	14.50
<i>Viola tricolor</i>	Protray	13.67	17.50	16.67	17.67	18.00	17.83	19.33	18.67
	Nursery bed	18.00	19.33	20.00	20.00	20.67	20.50	21.50	22.33
CD _{0.05}		1.21							

Days taken for seedling emergence varied among the different winter season annual flower crops, nursery raising methods and sowing dates. The number of days taken for seedling emergence ranges from 4.00 days (*Lupinus hartwegii*) to 26.50 days (*Antirrhinum majus*). However, the number of days taken for

seedling emergence is usually 2-3 days approximately when winter season annual flower crops are sown in the month of February- March and August- September in the hills (Kashyap *et al.* 2020) ^[6] and (Tobe K, *et al.* 2005) ^[11].

Table 3: Effect of winter season annual flower crops, sowing methods and sowing dates on harvesting (days)

Flower crops	Nursery raising method	Sowing dates							
		15 th October	30 th October	15 th November	30 th November	15 th December	30 th December	15 th January	30 th January
<i>Alyssum maritimum</i>	Protray	48.33	45.83	37.50	35.50	33.33	34.00	37.83	40.50
	Nursery bed	32.83	41.50	43.00	39.50	38.50	40.33	43.17	42.83
<i>Antirrhinum majus</i>	Protray	61.50	58.67	50.17	47.67	45.50	49.67	49.50	52.33
	Nursery bed	45.50	56.17	54.83	53.67	53.50	56.67	58.33	56.17
<i>Arctotis grandis</i>	Protray	51.00	49.83	39.83	36.50	34.67	36.00	39.33	39.50
	Nursery bed	34.83	45.50	45.00	45.33	40.83	43.50	45.17	45.67
<i>Calendula officinalis</i>	Protray	46.50	43.66	35.83	32.83	31.50	32.50	35.83	37.83
	Nursery bed	28.50	41.50	40.50	38.67	37.33	39.50	42.17	43.83
<i>Centaurea cyanus</i>	Protray	45.50	42.17	35.33	32.50	30.50	31.67	32.83	36.67
	Nursery bed	27.83	39.33	41.33	36.67	36.83	39.33	40.00	40.33
<i>Clarkia elegans</i>	Protray	49.00	45.67	37.67	36.17	35.50	33.50	40.00	41.17
	Nursery bed	33.83	42.33	43.83	41.50	41.67	41.83	48.00	45.00
<i>Delphinium ajacis</i>	Protray	53.17	50.83	42.67	41.00	37.50	39.50	43.00	45.50
	Nursery bed	38.50	48.50	49.83	43.17	43.33	48.33	50.17	50.50
<i>Dianthus barbatus</i>	Protray	50.17	49.50	40.50	37.67	35.50	36.50	40.17	41.83
	Nursery bed	33.50	46.50	47.33	42.00	42.67	45.50	48.33	47.83

<i>Dimorphotheca sinuate</i>	Protray	45.00	43.50	34.17	31.50	29.50	30.17	32.83	35.83
	Nursery bed	27.33	40.83	38.83	37.17	35.67	37.83	39.17	40.83
<i>Dorotheanthus bellidiformis</i>	Protray	56.50	53.50	44.83	42.67	39.83	42.67	45.83	46.83
	Nursery bed	41.67	50.50	49.50	48.33	46.83	51.83	53.50	52.00
<i>Glebionis coronaria</i>	Protray	51.00	50.83	40.83	37.83	37.50	37.50	42.50	43.17
	Nursery bed	35.50	46.33	47.33	44.83	45.67	48.50	50.50	50.33
<i>Godetia grandiflora</i>	Protray	49.50	45.83	37.83	36.66	35.66	34.50	39.00	40.50
	Nursery bed	33.66	43.33	43.66	41.50	40.83	42.50	48.33	45.33
<i>Helichrysum bracteatum</i>	Protray	49.50	48.17	37.83	35.50	33.67	34.83	38.50	40.17
	Nursery bed	32.50	45.50	45.50	41.50	40.83	43.50	46.83	46.33
<i>Iberis umbellata</i>	Protray	49.17	42.83	39.83	36.50	33.83	35.67	39.00	40.83
	Nursery bed	36.17	46.50	46.67	45.00	40.83	44.67	46.50	46.00
<i>Lupinus hartwegii</i>	Protray	44.00	40.83	32.83	30.50	28.50	29.33	32.17	35.50
	Nursery bed	26.83	37.50	39.33	35.33	34.67	38.17	38.17	37.83
<i>Papaver rhoeas</i>	Protray	48.50	43.17	35.83	34.67	34.33	32.50	37.50	39.83
	Nursery bed	32.83	40.83	42.17	39.50	40.50	39.83	42.33	43.00
<i>Viola tricolor</i>	Protray	51.33	46.67	42.83	38.67	36.67	38.67	42.33	44.00
	Nursery bed	36.83	47.17	48.50	46.50	42.67	48.17	50.33	48.67
CD _{0.05}		1.37							

The data pertaining to the interaction between flower crops x nursery raising methods x sowing dates is given in Table 3 reveals that *Lupinus hartwegii* sown in nursery beds on 15th October took the minimum number of days (26.83 days) for harvesting/production of ready to sale seedlings. In contrast, *Antirrhinum majus* sown in protrays on 15th October took the maximum number of days (61.50 days) for harvesting. The

earliness to harvesting may be attributed to the genetic makeup of each winter season annuals, better growing media, supplemental nutrition as well as environmental conditions during the growing period reported by (Gesch R W. 2013) ^[8]. The number of days taken for harvesting is usually a month when winter season annual flower crops are sown in the month of September- October (Kashyap *et al.* 2020) ^[6].

Table 4: Effect of winter season annual flower crops, nursery raising methods and sowing dates on seedling length (cm)

Flower Crops	Nursery raising method	Sowing dates							
		15 th October	30 th October	15 th November	30 th November	15 th December	30 th December	15 th January	30 th January
<i>Alyssum maritimum</i>	Protray	9.59	8.91	11.14	10.80	11.35	11.00	9.63	8.39
	Nursery bed	8.65	8.47	10.61	10.47	10.59	10.10	7.70	7.43
<i>Antirrhinum majus</i>	Protray	11.27	11.69	11.79	11.77	11.77	11.83	11.47	11.34
	Nursery bed	10.22	8.43	10.86	11.59	10.95	11.07	10.73	10.85
<i>Arctotis grandis</i>	Protray	12.73	11.51	14.09	13.32	12.81	13.03	9.83	11.95
	Nursery bed	13.03	10.90	11.49	12.75	12.43	12.52	11.22	11.16
<i>Calendula officinalis</i>	Protray	13.95	13.88	15.01	14.99	15.65	14.46	14.35	11.53
	Nursery bed	11.52	13.58	14.63	14.51	15.40	13.58	12.05	11.35
<i>Centaurea cyanus</i>	Protray	14.36	13.62	15.93	14.57	14.11	13.93	13.76	12.08
	Nursery bed	14.67	13.45	16.19	14.49	13.85	13.22	12.79	12.42
<i>Clarkia elegans</i>	Protray	12.11	12.06	12.31	12.58	12.83	12.65	11.84	11.87
	Nursery bed	11.17	11.71	12.78	11.89	12.28	11.89	11.37	11.11
<i>Delphinium ajacis</i>	Protray	12.95	12.36	14.05	13.22	12.98	12.72	9.39	9.75
	Nursery bed	12.46	12.34	12.63	12.75	12.19	12.40	8.66	9.15
<i>Dianthus barbatus</i>	Protray	8.34	7.97	7.84	8.53	9.20	8.49	9.25	8.11
	Nursery bed	7.92	7.48	8.32	8.84	8.64	7.91	8.37	7.76
<i>Dimorphotheca sinuate</i>	Protray	15.75	15.55	16.41	16.63	16.36	16.57	15.70	13.70
	Nursery bed	12.98	14.61	15.65	15.70	16.15	15.99	12.35	12.37
<i>Dorotheanthus bellidiformis</i>	Protray	11.27	11.15	10.99	11.65	11.59	11.44	9.00	8.79
	Nursery bed	10.33	9.32	10.90	10.88	10.27	10.33	7.66	7.86
<i>Glebionis coronaria</i>	Protray	8.69	7.35	9.69	10.95	11.29	11.31	11.58	11.23
	Nursery bed	8.45	7.44	9.12	11.21	11.14	10.75	10.71	10.64
<i>Godetia grandiflora</i>	Protray	13.27	13.07	14.00	12.94	12.99	12.91	11.35	11.54
	Nursery bed	13.07	14.76	13.79	13.22	12.52	12.75	11.51	10.67
<i>Helichrysum bracteatum</i>	Protray	11.51	10.81	11.65	11.69	11.68	11.63	7.89	8.95
	Nursery bed	10.49	10.67	11.95	11.89	11.17	11.17	8.01	7.36
<i>Iberis umbellata</i>	Protray	11.37	9.47	11.61	12.31	11.63	12.13	8.74	9.33
	Nursery bed	10.51	8.77	11.91	12.85	12.33	12.59	8.78	8.41
<i>Lupinus hartwegii</i>	Protray	11.69	11.54	12.56	12.43	11.90	12.47	11.50	12.04
	Nursery bed	11.27	11.43	12.25	12.41	12.53	12.21	12.00	11.55
<i>Papaver rhoeas</i>	Protray	7.87	8.11	10.13	8.66	12.49	8.78	8.36	9.14
	Nursery bed	7.66	8.45	9.36	8.37	11.75	7.64	8.44	8.29
<i>Viola tricolor</i>	Protray	10.58	10.61	11.39	12.13	12.62	12.05	8.61	8.88
	Nursery bed	10.65	9.83	11.49	12.19	12.14	11.79	8.83	8.30
CD _{0.05}		0.58							

Seedling length varied among the different winter season annual flower crops, nursery raising methods and sowing dates. The seedling length ranges between the maximum in *Centaurea cyanus* (16.19 cm) to the minimum in *Helichrysum bracteatum* (7.36 cm). The difference in the seedling length can be attributed to genetic makeup of each winter season annuals, availability of

more nutrients due better growing media and supplemental supply of NPK and also to the environmental conditions of the growing location. The seedling length decreases towards the latter months this may be because the time for vegetative growth decreases as the reproductive period approaches reported by (Abirami K, *et al.* 2010) ^[1].

Table 5: Effect of winter season annual flower crops, sowing methods and sowing dates on root length (cm)

Flower crops	Nursery raising method	Sowing dates							
		15 th October	30 th October	15 th November	30 th November	15 th December	30 th December	15 th January	30 th January
<i>Alyssum maritimum</i>	Protray	4.35	4.12	5.10	5.79	6.26	5.95	3.88	2.55
	Nursery bed	3.90	4.51	4.57	5.63	5.40	4.85	1.99	1.85
<i>Antirrhinum majus</i>	Protray	6.49	5.97	5.83	5.81	5.79	5.87	5.54	5.35
	Nursery bed	5.22	3.82	4.42	5.55	4.59	4.65	4.90	5.03
<i>Arctotis grandis</i>	Protray	6.30	5.72	6.51	7.19	6.94	6.91	3.87	5.15
	Nursery bed	6.47	4.66	6.67	6.46	6.26	5.99	3.71	4.02
<i>Calendula officinalis</i>	Protray	6.47	6.12	6.82	7.69	8.48	7.26	5.89	5.41
	Nursery bed	4.55	4.67	6.71	6.91	7.77	5.85	6.21	5.83
<i>Centaurea cyanus</i>	Protray	4.79	4.79	5.87	5.80	5.96	5.33	3.59	3.13
	Nursery bed	5.22	4.26	6.37	5.65	5.27	4.12	4.28	3.66
<i>Clarkia elegans</i>	Protray	5.25	5.25	6.25	5.96	5.95	5.93	4.79	4.42
	Nursery bed	5.00	5.34	7.55	5.16	5.27	4.39	4.26	3.91
<i>Delphinium ajacis</i>	Protray	7.02	6.63	8.48	7.30	7.47	6.97	4.61	3.99
	Nursery bed	5.70	6.03	7.15	7.10	6.20	6.19	2.85	3.29
<i>Dianthus barbatus</i>	Protray	4.03	4.09	3.68	4.43	4.97	4.49	4.00	3.03
	Nursery bed	3.42	3.54	4.15	4.70	4.33	3.33	3.57	2.97
<i>Dimorphotheca sinuate</i>	Protray	5.51	5.31	6.41	6.80	6.50	6.53	5.69	4.44
	Nursery bed	5.13	5.77	5.33	5.29	5.25	4.97	3.86	3.89
<i>Dorotheanthus bellidiformis</i>	Protray	6.15	5.82	4.45	7.46	7.72	7.23	3.47	3.27
	Nursery bed	5.57	4.72	4.20	6.56	6.27	5.73	2.15	1.95
<i>Glebionis coronaria</i>	Protray	2.99	3.33	3.87	4.63	5.15	5.17	5.39	5.04
	Nursery bed	2.77	3.21	3.81	4.55	4.79	4.29	4.78	4.59
<i>Godetia grandiflora</i>	Protray	5.85	5.91	5.89	5.92	6.09	5.75	4.66	5.01
	Nursery bed	5.17	5.87	5.68	5.79	4.82	4.89	5.09	4.23
<i>Helichrysum bracteatum</i>	Protray	6.17	6.14	6.83	6.30	6.55	6.55	2.87	3.03
	Nursery bed	4.59	5.93	7.37	6.45	5.87	5.67	3.21	2.67
<i>Iberis umbellata</i>	Protray	6.11	4.26	5.31	6.99	7.37	7.11	3.21	3.71
	Nursery bed	5.55	3.96	4.69	7.43	7.21	7.05	4.75	4.09
<i>Lupinus hartwegii</i>	Protray	4.71	4.59	5.24	5.74	5.79	5.85	4.66	4.16
	Nursery bed	4.68	5.01	4.53	5.67	5.57	4.98	4.19	3.66
<i>Papaver rhoeas</i>	Protray	3.73	4.11	5.35	4.97	5.71	4.62	4.30	4.65
	Nursery bed	3.31	3.93	4.17	4.68	4.25	3.01	3.94	3.77
<i>Viola tricolor</i>	Protray	5.33	5.11	6.26	6.83	6.48	6.30	3.21	3.09
	Nursery bed	4.84	4.15	5.81	6.48	5.99	5.75	3.03	2.51
CD _{0.05}		0.42							

Root length varied among the different winter season annual flower crops, nursery raising methods and sowing dates. The root length ranges from the longest in *Calendula officinalis* and *Delphinium ajacis* (8.48 cm) to the shortest in *Alyssum maritimum* (1.85 cm). The difference in the root length may be due to the genetic makeup of each winter season annuals, more availability of space and nutrients environmental factors as well

as the edaphic factors of the growing location close conformity with (Sumera S, *et al.* 2022) ^[10].

Amongst the 17 different winter season annual flower crops, *Lupinus hartwegii* recorded the maximum seedling fresh weight (175.92 mg) and seedling dry weight (67.17mg) whereas, *Papaver rhoeas* recorded the minimum seedling fresh weight (1.68 mg) and seedling dry weight (0.17 mg).

Table 6: Seedling fresh weight (mg) and seedling dry weight (mg) of different winter season annual flower crops

Flower crops	Seedling Fresh weight (mg)	Seedling dry weight (mg)
<i>Alyssum maritimum</i>	6.14	1.97
<i>Antirrhinum majus</i>	2.11	1.23
<i>Arctotis grandis</i>	13.58	4.40
<i>Calendula officinalis</i>	56.71	28.33
<i>Centaurea cyanus</i>	55.59	24.60
<i>Clarkia elegans</i>	5.84	1.33
<i>Delphinium ajacis</i>	28.18	15.00
<i>Dianthus barbatus</i>	8.30	5.97
<i>Dimorphotheca sinuate</i>	76.02	34.00

<i>Dorotheanthus bellidiformis</i>	5.55	2.27
<i>Glebionis coronaria</i>	16.44	5.73
<i>Godetia grandiflora</i>	8.69	5.27
<i>Helichrysum bracteatum</i>	8.21	2.57
<i>Iberis umbellate</i>	19.37	11.73
<i>Lupinus hartwegii</i>	175.92	67.17
<i>Papaver rhoeas</i>	1.68	0.17
<i>Viola tricolor</i>	6.37	5.77

Dimorphotheca sinuata recorded the highest Seedling Vigour Index I (2487.15) whereas, *Antirrhinum majus* recorded the lowest i.e., 117.00 among the different winter season annual flower crops. These findings were in accordance with Mittal (2013) [9]. However, the values were higher in the case of Mittal (2013) [9] due to higher germination percentage.

Table 7: Seedling vigour index I of different winter season annual flower crops

Flower crops	Seedling vigour index I
<i>Alyssum maritimum</i>	855.27
<i>Antirrhinum majus</i>	117.00
<i>Arctotis grandis</i>	1116.48
<i>Calendula officinalis</i>	1074.64
<i>Centaurea cyanus</i>	1231.47
<i>Clarkia elegans</i>	746.40
<i>Delphinium ajacis</i>	1523.95
<i>Dianthus barbatus</i>	905.01
<i>Dimorphotheca sinuata</i>	2487.15
<i>Dorotheanthus bellidiformis</i>	180.53
<i>Glebionis coronaria</i>	195.60
<i>Godetia grandiflora</i>	737.87
<i>Helichrysum bracteatum</i>	393.52
<i>Iberis umbellate</i>	1078.33
<i>Lupinus hartwegii</i>	856.27
<i>Papaver rhoeas</i>	470.17
<i>Viola tricolor</i>	957.33
CD _{0.05}	135.45

Table 8: Seedling vigour index II of different winter season annual flower crops

Flower crops	Seedling vigour index II
<i>Alyssum maritimum</i>	18.63
<i>Antirrhinum majus</i>	1.97
<i>Arctotis grandis</i>	36.29
<i>Calendula officinalis</i>	131.41
<i>Centaurea cyanus</i>	159.71
<i>Clarkia elegans</i>	10.44
<i>Delphinium ajacis</i>	113.08
<i>Dianthus barbatus</i>	50.96
<i>Dimorphotheca sinuata</i>	275.72
<i>Dorotheanthus bellidiformis</i>	8.36
<i>Glebionis coronaria</i>	11.83
<i>Godetia grandiflora</i>	39.30
<i>Helichrysum bracteatum</i>	14.52
<i>Iberis umbellate</i>	90.14
<i>Lupinus hartwegii</i>	480.38
<i>Papaver rhoeas</i>	14.27
<i>Viola tricolor</i>	43.20
CD _{0.05}	31.35

Among the different winter season annual flower crops, *Lupinus hartwegii* recorded the highest Seedling Vigour Index II (480.38), *Antirrhinum majus* recorded the minimum value (1.97). These findings were in line with Mittal (2013) [9]. However, the values were higher in the case of Mittal (2013) [9] due to a higher germination percentage.

Conclusion

Annuals can be produced successfully over an extended period of time beyond the months of September and October. The protrait method performed better than nursery beds, with higher germination and better seedling growth, improved seedling vigour and quality, and was preferred by consumers (77.25%). From the present study, it can be concluded that protraits performed better than nursery beds.

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