DETERMINATION OF SOME AGRONOMICAL AND DYEING PROPERTIES OF DYER'S CHAMOMILE (ANTHEMIS TINCTORIA L.)

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ABSTRACT

The present study was designed to determine some agronomical properties and fastnesses of dyeing (against light, abrasion and dry and wet water spotting) with Anthemis tinctoria, which is a perennial herb, used as traditional dyeing in many places of the world. The field experiment was laid out in a randomised block design with three replications and four plant densities (20 x 10 (500.000 plant/ha), 20 x 20 (250.000 plant/ha), 40 x 10 (250.000 plant/ha), 40 x 20 (125.000 plant/ha), 60 x 10 (166.600 plant/ha) and 60 x 20 cm (83.300 plant/ha) were used, respectively. In the field trial, flower diameter length varied between 1.53-1.84 mm, fresh flower head yield varied between 2.42-14.19 kg. ha^{-1} and dry flower head yield varied between 0.9-3.61 t. ha^{-1}. For dyeing, alum of aluminium, copper-sulphate, zinc-chloride, potassium-bichromate, sodium chloride, sodium sulphate, sodium sulphite and iron-sulphate were used as mordant. A total of 25 dyeing treatments were performed, and very different colours and their tons were obtained.

KEYWORDS: Anthemis tinctoria; Dyer's Chamomile, flower head yield, dyeing methods, fastnesses

INTRODUCTION

Until the end of the 19th century, dyes of plant origin were applied alone for dyeing. Through the discovery of the synthetic dyes at the end of the last century, the natural dyes disappeared and the old traditional dye methods falled into oblivion. Once the health hazards of many synthetic dyes have been known, the industry looks for more ecologically friendly products. Therefore, dye plants become interesting again (Anonymous, 1997). Natural colourants and dyestuffs are an important group of non-food forest products. They can be of plant or insect origin. These products have various uses. Natural colourants are employed to impart colour to textiles and other non-food products.

The number of colourants and dyestuffs found in nature are enormous. While some of them are fairly well known, many are not commercially important.

Anthemis tinctoria, commonly named as yellow chamomile, golden marguerite and dyers chamomile is a hardy perennial which produces a mass of foliage from which many yellow composite flowers emerge. It produces a deep yellow dye, which is extracted from the blossoms and requires mordanting to make it fast. It provides alternative yellows to those extracted from other dye-plants eg. weld or golden rod (Anonymous, 1997). Its dye has a great significance in food industry due to the presence of natural yellow dyes used at the production of diary and butchery products. The main components therein are natural flavonoids and essential oils. The average content of flavonoids reached values between 1,05 and 2,56 % (Vaverkova et al. 2000). In addition, with regard to vegetable dyeing, Dyer's Chamomile has isorhamnetin and quercetin (Anonymous, 1991). The species of Anthemis genus have found broad use in the pharmaceutical and cosmetic industry, and food industry. Medically, seed oil was used to treat earaches, deafness; plant is said to be antispasmodic and stimulate menstrual flow.

Textiles dyed with natural dyes show a resistance against sweat, washing and rubbing, which satisfies industrial requirements. However, at present, the resistance to photo-bleaching is not sufficient. Also, agriculture of dye plants is not sufficient for vegetable dye production in the worldwide. Textile and food industry require materials non-threated environment and human health. For this reason, vegetable dye production could be encouraged.

The purpose of this study is to determine some agronomical properties of Dyer's chamomile, performed dyeings using its flower heads by different mordant and determine colours fastnesses.

MATERIALS AND METHODS

Field Experiment

Field studies were conducted under Diyarbakır ecological conditions at the Department of Field Crops, Agricultural Faculty, Dicle University between 2002-2003 and 2003-2004 growing seasons. The seeds used in the field experiment were obtained from the Department of Field Crops, Agriculture Faculty of Ankara University.

Seeds of Dyer's Chamomile were sown in high-tunnel on 15 December 2002. Prior to sowing, the seedbed was prepared by using 1/3 soil, 1/3 sand and 1/3 farmyard manure. Field trial was conducted according to Randomised Block Design with three replications. When the seedlings reached 10-15 cm height, each plot was arranged as 4 rows and 20 x 10 (500.000 plant/ha), 20 x 20 (250.000 plant/ha), 40 x 10 (250.000 plant/ha), 40 x 20 (125.000 plant/ha), 60 x 10 (166.666 plant/ha) and 60 x 20 cm (83.333 plant/ha) respectively, and the plants were transplanted to the field on 13 April 2003. During the vegetation period, the plots were weeded when needed, and after each harvest the plots were irrigated, orderly.

In the field trial, for Anthemis tinctoria plant height, flower diameter length, diameter of flower heads, the number of flower, fresh and dry flower yield were evaluated. Fresh tables were dried in a shadow and airy place for one week.

Data obtained were analysed statistically, using MSTAT-C program, and means were grouped, using LSD values at a significance level of 5%.

Dye Material

Woollen carpet yarns used in dyeing were colourless and had a thickness degree of 2.5 Nm. As mordant, alum of aluminium, copper-sulphate, zinc-chloride, potassium-bichromate, sodium chloride, sodium sulphate, sodium sulphite and iron-sulphate were used.

Dyeing Methods

In the dyeing of woollen yarn with Dyer's Chamomile, dyeing methods, pre-mordanting, last-mordanting, with and without mordanting methods were used. Preparation of dye extract was the same in all dyeing methods.

Preparation of Dye Extract

Flower heads of Dyer's Chamomile were cut into small pieces. Dye material the weights of which were equal to woollen yarn, were taken separately and boiled in water at a rate of 1/50 for one hour. The water that decreased during boiling was added. Later, plant remainders were filtered, and the extract was obtained.

Dyeing without Mordant

Woollen yarn that was damped previously was boiled in dye extract for one hour. During boiling, when the amount of the water decreased, more water was added. After one hour, dyed yarn was cooled, then rinsed with cold water and dried at shading and airy place.

Pre Mordanting

In the present study, woollen yarn was treated with the chemicals indicated above. Out of woollen yarn weight, 3% mordant were used. Mordant taken according to woollen yarns weight was dissolved in the tepid water that was 50 times heavier than the woollen yarn. Yarn dampened previously was boiled in this water about one hour. Woollen yarn taken from water was ready to dye after pressing. Yarn was treated with all of the mordants separately.

Last Mordanting

Firstly, woollen yarn was dyed the same as without mordanting dyeing. Then, out of woollen yarn weight, 3% mordant was used. Mordant taken according to woollen yarns weight was dissolved in the tepid water that was 50 times heavier than the woollen yarn. Yarn was treated with all of the mordants separately and boiled for one hour. Thus, the last mordanting was performed. After cooling, it was rinsed with abundant cold water and dried at shading and airy place.

Treatment With Mordant

When wool yarns were put in dye extract, at the same time, previously determined mordant amount was added in extract and boiled together for one hour. Thus, it is not only dyed but also mordanted. After cooling, it was rinsed with abundant cold water and dried at shading and airy place.

Naming The Colours

A total of 25 dyeings with Dyer's Chamomile were performed. Colours that were obtained by dyeing were named by the specialists of University of Ankara, Faculty of Agriculture, College of Home Economy, Unit of Textile and Wearing, Department of Village Hand Craft as below; dyed woollen samples were spread out on the white ground where the sun light come from the side. They were divided into groups according to colour differences, and common colour names were given separately.

Light Fastness Determination

Light fastness determination was carried out on the basis of TS 867 prepared by TSE (colour fatness determination methods according to sunlight) (Anonymous, 1984a) and DIN 5033 (Farbmessung Begrifte der Farbmetrik) (Anonymous, 1970).

Abrasion Fastness Determination

Abrasion fastness determination was carried out according to TS 717 (determination of colour fatness according to abrasion) prepared by TSE (Anonymous, 1978a) and TS 423 (using methods of grey scale for sum up the staining "leaking of dye" and discolouring "changing of colour", in the determination of colour fastness of textiles) (Anonymous, 1984b).

Dry and Wet Water Spotting Fastness Determination

Water fastness determination was performed according to TS 399 (determination of colour fastness according to water spotting) prepared by TSE (Anonymous, 1978b) and TS 423 (Anonymous, 1984b).

RESULTS AND DISCUSSION

Field experiment

The results of analyses of variance over two years for five characters observed in Dyer's chamomile are given in Table 1 and 2. It is shown that plant height was not found to be statistically significant among plant densities. The highest values were obtained from 66.9 cm and 65.3 cm at 40x20 and 20x20 plant densities, respectively.

Flower head diameter length was found to be statistically significant among plant densities. The highest diameter length was obtained from at 40x10 plant density as 1.84 mm. The first year flower heads diameter length values were higher than the second ones.

The numbers of flower heads per plant for both years on average were found to be significant. The number of flower values varied between 121.5-148.6 pieces/plant. Wider plant densities produced more flower heads than narrow ones. This can be effect the yield of fresh and dry matter yield and dye quantity.

The aim of dye plant cultivation should not only be high hectare yield but also a product high quality, which means high content of dye material, and determination of right harvest time is much more important. In the study, harvests were accomplished when flower heads came in harvest maturity.

Dyer's chamomile was cultivated for flower heads and dyeing industry uses these. In the first year of trial, five harvests were performed, whereas the second year only one harvest was performed. Plant densities were significantly effect fresh flower head yield. The highest yield was obtained from narrow plant density, which was 20x10. Just as fresh flower heads yield, dry flower head yield was significantly affected from plant densities. The highest dry flower head yield was obtained from 20x10 cm plant density.

Hartl and Vogl, (2003) reported that dry matter yields of Dyer's Chamomile were found (flower heads) between 1.1 and 1.8 t ha^{-1}. In our study, the results obtained are higher. Vetter et al. (1999) reported that Dyer's chamomile yielded 2-2.5 t ha-1. These results are compatible with the average of our results (Table 2).

Dyeing results

Table 1. The means and groups of plant height, flower heads diameter length and the number of flower opened obtained from the trial

Treatment	Plant height (cm)			Flower head diameter length (mm)			Number of flower head per plant (Pieces/plant)		
Plant density	2002-03	2003-04	Mean	2002-03	2003-04	Mean	2002-03	2003-04	Mean
20x10	47.1	60.3	53.7	1.78 ab	1.53 e	1.66	114.1	120.3	117.2 b
20x20	43.2	65.3	54.2	1.70 bc	1.57 de	1.64	124.2	141.3	132.8 ab
40x10	44.9	57.3	51.1	1.84 a	1.64 cde	1.74	133.2	109.8	121.5 b
40x20	36.5	66.9	51.7	1.67 bcd	1.67 bcd	1.67	147.2	150.0	148.6 a
60x10	44.4	64.8	54.6	1.76 ab	1.71 bc	1.74	151.5	120.2	135.9 ab
60x20	43.8	56.8	50.3	1.76 ab	1.57 de	1.67	155.8	138.7	147.2 a
Mean	43.3	61.9		1.75	1.62		137.7	130.0	
LSD (0.05)	ns*			Int: 0.1204			Plant density: 22.17		

*Means followed by the same letters are not significantly different at 5% level, ns: non-significant

Table 2. The means and groups of obtained from the trial

Treatment	Fresh flower head yield (t. ha. $^{-1}$)			Dry flower head yield (t. ha. $^{-1}$)		
Plant density	2002-03	2003-04	Mean	2002-03	2003-04	Mean
20x10	14.19 a	6.81 bcd	10.51	3.61 a	2.46 bc	3.03
20x20	7.62 b	8.04 b	7.83	2.48 bc	2.96 ab	2.72
40x10	7.39 bc	3.59 de	5.49	2.11 cde	1.41 def	1.76
40x20	3.57 de	3.65 de	3.61	1.05 f	2.18 bcd	1.62
60x10	4.07 cde	6.56 bcd	5.31	1.31 ef	1.36 ef	1.33
60x20	3.95 de	2.42 e	3.18	1.17 f	0.90 f	1.03
Mean	6.80	5.18		1.95	1.88	
LSD (0.05)	Int: 3.436			Int : 0.8197		

*Means followed by the same letters are not significantly different at 5% level.

Colours are obtained as a result of dyeings and the fastness of colours such as light, abrasion, dry and wet water spotting are determined and given in Table 3. The dyestuff of Dyer's chamomile is mordant dyes. It needs a mordant to be fixed on the fiber and woollen, in the most cases metal salts are used.

When Table 3 was analysed, the colours obtained from the Dyer's chamomile were determined different yellow tones such as saffron, straw yellow, light mustard, cumin, mustard, mouldy lemon, light chick yellow, light yellow and greenish yellow. As these colours have the shades of green and yellow, they are mostly used in the hand-woven carpets and kilims.

In Table 4, when light fastness values are investigated, it is seen that they vary between 1-8. The lowest value is 1, obtained from dyeing with zinc-chloride.

The abrasion fastness values were between 2 and 5. These values are at medium and good level.

Wet water-spotting fastness values were found to vary between 3-5 and dry as 5, which is at medium and good level. This indicated that dry water spotting fastnesses were found at good level, and that no staining was seen on the wool, after water dried.

Previous studies have pointed that wool dyed with Dyer's Chamomile by using mordant could be obtained such as yellow, olives green, metallic yellow, cinnamon yellow, and bright orange colours (Anonymous, 1991). Ölmez (2002) reported that colours obtained from Anthemis tinctoria are dark yellow, light yellow and yellow and fastness values of light was determined as 3-5, abrasion fastness determined as for weight abrasion 4-5 and 5, dry abrasion 3-4. These obtained colours and fastness values in agreement with results of our study. Also, other researchers argued that Dyer's chamomile gives brown yellow and duller dyes (Anonymous, 1997). In our opinion, these differences may be due to sources of dye material, dye content of plant and mordants used in dyeing.

Hartl and Vogl (2003) reported that dyeing with Dyer's chamomile had no irregularities. Moreover, the colours obtained were a rich dark green yellow shade. Researchers pointed that fastness grades of 3-4 for natural dyestuff are

Table 3. The colours obtained from dyer's chamomile and, light, abrasion, dry and wet water spotting fastness of these colours

	Mordant name	Mordant rate	Colours	Light fastness	Abrasion fastness	Water spotting fastness	
						Wet	Dry
Pre-mordanting	Alum of aluminium	3	Saffron	3	2-3	3	5
	Copper-sulphate	3	Sulphur	6	3-4	4-5	5
	Zinc-chloride	3	Light mustard	1	2-3	5	5
	Potassium-bichromate	3	Dark saffron	4	3-4	5	5
	Sodium chloride	3	Straw yellow	2	4	5	5
	Sodium sulphate	3	Straw yellow	-	4-5	4	5
	Sodium sulphite	3	Straw yellow	2	4	4-5	5
	Iron-sulphate	3	Cumin	5	3	4	5
With-mordanting	Alum of aluminium	3	Light yellow	2	3	5	5
	Copper-sulphate	3	Bleeding olive oil	4	3	4-5	5
	Zinc-chloride	3	Greenish yellow	2	3	5	5
	Potassium-bichromate	3	Light chick yellow	3	4-5	5	5
	Sodium chloride	3	Light dirty yellow	3	4-5	5	5
	Sodium sulphate	3	Straw yellow	3	4-5	5	5
	Sodium sulphite	3	Light dirty yellow	5	3	5	5
	Iron-sulphate	3	Green-grey	6	2	3-4	5
Last-mordanting	Alum of aluminium	3	Light straw yellow	3	4	4-5	5
	Copper-sulphate	3	Mouldy lemon	8	4	3-4	5
	Zinc-chloride	3	Light straw yellow	3	4	3-4	5
	Potassium-bichromate	3	Dark straw yellow	5	4	5	5
	Sodium chloride	3	Cream	4	4	5	5
	Sodium sulphate	3	Light dirty yellow	4	4-5	5	5
	Sodium sulphite	3	Beige	2	4	5	5
	Iron-sulphate	3	Light soil	6	2-3	5	5
Non-mordant			Straw yellow	3	4	5	5

good and very good fastness data. Light fastness grades of Dyer' chamomile was determined 2, 2-3 and 3. Light fastness of this study is better than results of Hartl and Vogl (2003). These differences may be due to dye content of plants. It is known that dyestuff content of the plants could be altered by plant origin and some agronomical and environment conditions. Some researchers reported that Dyer's chamomile dyestuff content varied between 4-5% (Vetter et al., 1999), 2.54-6.82% (Biertümphel and Vetter, 1999) and 1.64-2.43 (as quercettin) (Hartl and Vogl, 2003).

CONCLUSION

Many plant species can be used for dyeing. Therefore it is an important aim in research to screen and select species, which fit for modern sustainable cultivation techniques as well as for dyeing on large scale. Anthemis tinctoria is widely used as a dye plant and commonly employed in dyeing industry. Field trials showed that Dyer's chamomile could be cultivated successfully in wide areas for one or two years. Through paper, we want to encourage further studies on the growing and dyeing processing of dye plants.

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