DOUGLAS' DUSTYMAIDEN INITIAL EVALUATION PLANTING FINAL STUDY REPORT

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ABSTRACT

There is increasing demand for new, broadly adapted forb releases for use in conservation, wildlife and pollinator plantings. From 2007 through 2010 Aberdeen Plant Materials Center conducted an initial evaluation planting (IEP) on Douglas' dustymaiden to determine if the species was suitable for large scale production and use in conservation plantings. Following initial evaluations, accession 9076577 from Boise County Idaho was selected for grow out with the intent of a Selected Class Release. However, after several attempts, establishment of the Breeder Block was insufficient to develop the desired quantity of seed. Due to these difficulties, the Douglas' dustymaiden project was terminated in 2012.

INTRODUCTION

There is increasing demand for releases of native forbs for use in revegetation efforts throughout western North America. Native forbs are important for increasing biodiversity, improving wildlife habitat and providing food for numerous birds and mammals. Douglas' dustymaiden (*Chaenactis douglasii*) (Hook.) Hook. & Arn. has been identified as a forb that may be suitable for use in rangeland reclamation and restoration in the Intermountain West. Seed is not readily available commercially, and there are no officially released accessions of this species. The goal of this trial was to identify one or more superior Douglas' dustymaiden accessions adapted for use in the Aberdeen Plant Materials Center service area.

Dustymaiden is a biennial, or short-lived perennial forb, developing from a basal rosette of grayish multi-lobed leaves. Flowering stems generally reach 30 to 60 cm (8 to 25 in) tall and are topped with white to pinkish composite flowers. The fruit is a golden to black achene, approximately 8 mm (0.3 in) long with 10 to 16 membranous pappus scales (Welsh et al. 2003). This species is highly diverse morphologically and has been treated by taxonomists as a single species, or as up to ten different species with six varieties. The PLANTS database currently recognizes one species with two varieties, *douglasii* and *alpina* (USDA, 2009).

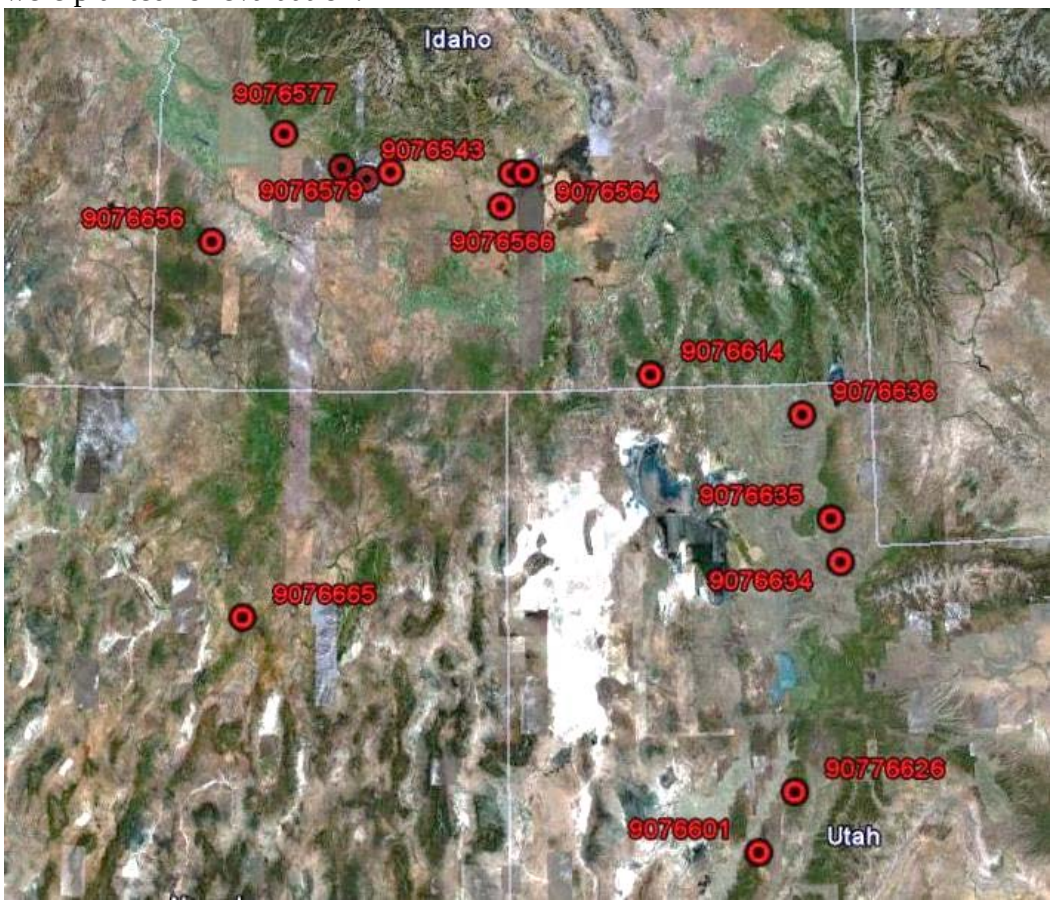
Douglas' dustymaiden is adapted to medium to coarse textured soils with a pH of 4.2 to 8.0 (Borden and Black, 2005), and a minimum 25 cm (10in) rooting depth (USDA-NRCS, 2009). Dustymaiden occurs throughout western North America at elevations near sea level to 3,000 m (10,000 ft), from British Columbia to Arizona, ranging as far east as South Dakota. The species can be found in a variety of plant communities in the Intermountain West including shadscale, sagebrush, pinyon-juniper, mountain brush and pine-fir forests in areas receiving 25 to 150 cm (10 to 60 in) annual precipitation (USDA, 2009). Douglas' dustymaiden is also a common colonizer of waste rock surfaces and may be useful in reclamation programs in the semiarid Intermountain West (Borden and Black, 2005). Dustymaiden appears to compete well against invasive knapweed species (*Centaurea* spp.) which are known to use an

alelopathic chemical called (±)-catechin to inhibit germination and root development of competing or adjacent plants (Perry et al., 2005). Observations of Douglas' dustymaiden in association with knapweed species may suggest a resistance to these chemicals.

MATERIALS AND METHODS

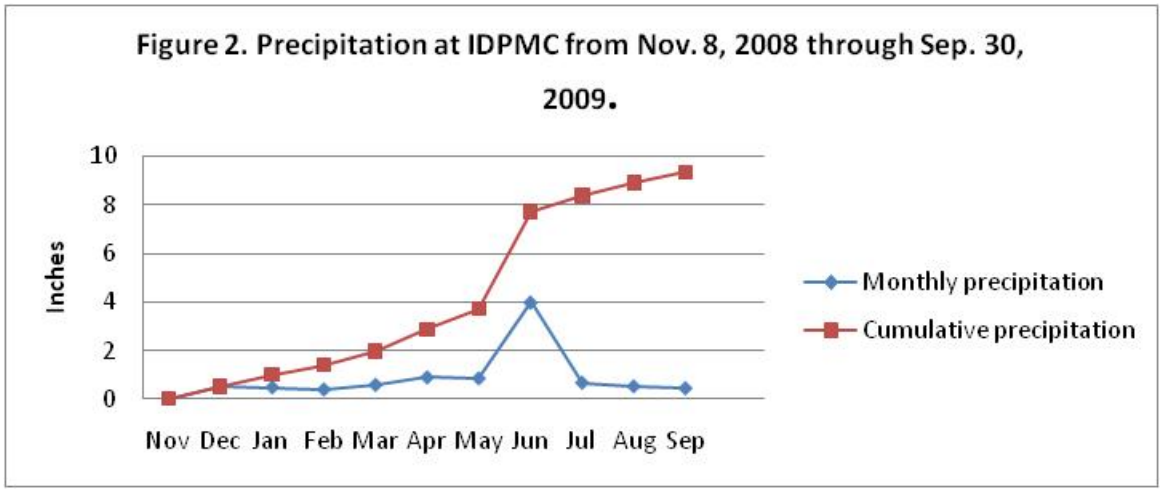
Seed collection took place during the 2007 and 2008 growing seasons; seed is ripe in July through August. A total of 25 collections were made, of which 15 were selected for inclusion in the trial. Collection locations were throughout the Intermountain West and represent populations found in Major Land Resource Areas B10A, B11, D25, D28A and E47 (USDA, 2006) (see appendix 1 and 2 for collection location information). The best method found to collect wildland seed with little additional vegetative material was by bending the top of the plant into a bag and vigorously shaking the ripe seed off. Following collection, seed was stored in open collection sacks to dry prior to processing. Seed lots were then cleaned using an air-screen cleaner and placed into storage at 10° C (50º F) until planting.

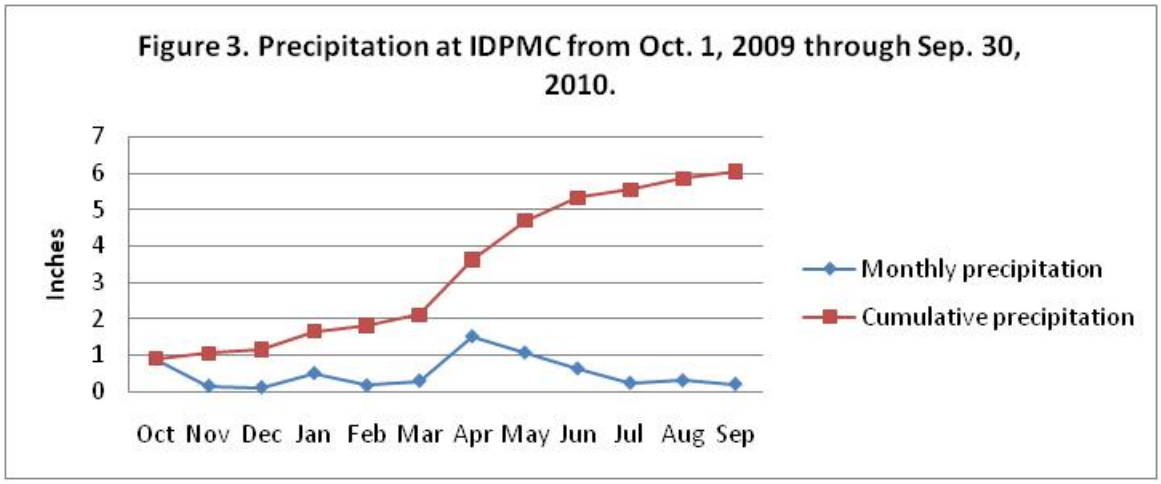
Figure 1. Map of collection sites for Intermountain Douglas' dusty maiden IEP. Fifteen of 25 collections were planted for evaluation.



The trial was conducted at the PMC Home Farm 2 miles north of Aberdeen, ID. Soil is a Declo silt-loam with a pH of 8.4. Weed-barrier fabric was laid over a well-prepared bed to reduce weed competition. Each plot consisted of three rows of four, three inch diameter holes (12 total) with 9 inch hole spacing. The plots were laid out linearly along the fabric in four blocks for replication. The trial was seeded on November 8, 2008. Each hole was seeded with a target of 12 to 25 seeds.

Weather during the first year of establishment and evaluation (2009) was typical for southeastern Idaho with high temperatures averaging near 90º F in the summer and dropping into the teens during winter months with occasional dips below zero (Bureau of Reclamation, 2010). Precipitation for the year was above average (figure 2). Total accumulated precipitation received was 11.45 inches including an abnormal 3.82 inches of rain in June. Mean annual precipitation for the site is 9.39 inches (Bureau of Reclamation, 2010). Aberdeen received 6.06 inches of precipitation during water year 2010 (figure 3). The plots did not receive any supplemental irrigation or fertilization either year.





On July 9, 2009 the plots were evaluated for percent establishment, average plant height, plant vigor, and flower production. Establishment was recorded as the number of holes per plot containing plants divided by 12 holes. Vigor and flower production for each plot were assigned a visual rating of 1-9 with 1 being best and 9 being worst or dead. On August 6, an estimated seed yield per plot was recorded using the same 1 to 9 scale. Also on August 6, seed collections were made from the top seed producing plot in each replication to be used to develop seed cleaning protocols. All data were analyzed with a one-way analysis of variance to determine significance with an α of 0.05. In cases where significance was found, a Tukey's multiple comparison was used to separate means.

Plots were evaluated in 2010 on March 8, and May 10 for percent stand, and on June 21 for height and vigor. On June 14, the plots were evaluated for percent flowering. Percent flowering was then plotted against the latitude of the original population site to create a scatter plot graph to show phenology from

different populations. Means from the 2010 data were separated using a least significant difference (LSD) test.

RESULTS

Establishment rates were good for all accessions (table 1). Of the fifteen accessions, only one (9076643) had an establishment rating below 80% (accession 9076643 with 66% establishment). Despite lower germination and establishment, accession 9076643 had the tallest plants recorded in 2009 with a mean height of 46 cm and the highest rated flower production (2.8). Accession 9076643 also tied for best vigor and seed yield ratings (3).

Figure 4. Dustymaiden growing in weed barrier fabric. Photo taken Aug. 2009. Photo by Loren St. John.

Table 1. 2009 evaluation of Douglas' dusty maiden.

		Jul 9			Aug 6
Accession	Establishment	Height	Vigor	Flower prod.	Seed yield
	----%----	---cm---	----------(1-9)----------		
9076566	98 a	42 a-b	3[a]	3.8 a-c	5
9076572	98 a	33 a-d	3	4.0 a-d	4
9076636	96 a	33 a-d	3	6.0 a-d	3
9076575	96 a	42 a-b	3	3.8 a-c	5
9076635	96 a	40 a-c	3	4.5 a-d	3
9076656	96 a	37 a-d	3	3.3 a-b	5
9076579	92 a	35 a-d	3	4.5 a-d	5
9076634	91 a	27 c-d	4	7.5 c-d	5
9076564	89 a-b	42 a-b	3	5.0 a-d	4
9076665	89 ab	36 a-d	4	4.0 a-d	4
9076626	87 ab	25 d	4	8.0 d	5
9076601	87 ab	29 b-d	4	7.3 b-d	5
9076577	85 ab	36 a-d	3	4.8 a-d	3
9076614	83 ab	36 a-d	4	4.5 a-d	4
9076643	66 b	46 a	3	2.8 a	3
Critical value (0.05)=	24	14	NA	4.0	NA

[a] Vigor, flower production and seed yield for each plot were assigned a visual rating of 1-9 with 1 being best and 9 being worst or dead.

Most accessions in the trial had good recovery from dormancy going into the 2010 growing season according to the March evaluation (table 2). Those that didn't come back with good stands, accession 9076665 for example, may have been less adapted to conditions in Aberdeen, or they came from populations of predominately annual plants. Most stands continued to decline through the May 2010 evaluation; however there were several accessions that maintained excellent stands from 2009 to 2010.

Table 2. 2010 evaluation of Douglas' dusty maiden.

			June 14,		
	Mar 8, 2010	May 10, 2010	2010	Jun 21, 2010	
Accession	Stand	Stand	% Flower	Height	Vigor
	%	%		---cm---	(1-9)
9076566	85.5 a-c	83.3 a	1.25 d	42.5 a-b	3.50 a-c
9076572	60.3 c-f	43.8 c-g	1.77 d	35.2 c-d	6.50 d-f
9076636	89.5 a-b	72.9 a-c	32.50 c	38.7 b-d	2.25 a
9076575	91.8 a	85.4 a	3.00 d	48.9 a	3.00 a-b
9076635	83.5 a-c	77.1 a-b	68.75 a	36.8 b-d	2.50 a-b
9076656	64.5 b-f	50.0 b-g	1.25 d	36.2 b-d	6.00 c-e
9076579	56.3 d-f	41.7 e-g	0.24 d	27.1 e	8.00 e-f
9076634	89.8 a-b	70.9 a-d	50.00 b	37.5 b-d	3.00 a-b
9076564	54.3 d-f	25.0 g	3.44 d	31.8 d-e	7.00 d-f
9076665	27.0 g	22.9 g	8.57 d	23.9 e	9.00 f
9076626	77.3 a-d	66.7 a-e	42.50 b-c	34.9 c-d	5.00 b-d
9076601	50.0 e-g	39.6 e-g	13.75 d	36.2 b-d	7.00 d-f
9076577	74.8 a-e	64.6 a-f	1.25 d	48.9 a	2.00 a
9076614	62.5 c-f	47.9 c-g	11.90 d	38.8 b-c	6.00 c-e
9076643	41.5 f-g	37.5 f-g	7.04 d	37.6 b-d	6.00 c-e
LSD (0.05)=	25.8	28.3	varies	varies	2.59

Height and vigor measurements taken in mid-June showed a broad range of growth and appearance between accessions. Accession 9076577 tied with accession 9076575 for tallest plants, and 9076577 likewise had the best vigor rating.

In 2011, the plots were evaluated on May 2, for survival. A small number of live plants were found from accessions 9076572, 9076636, 9076665, 9076614, 9076564, 9076656, 9076643 and 9076635.

By comparing flowering dates with the latitude of the original collection site for each population, it was determined that northern collections generally flower later in the season than most of the collections from southern latitudes (figure 5). A group of more southerly populations (accessions 635, 634, 626 and 636, shown in green) had an average of 48.4% blooming at June 14, 2010, while three promising northern collections (accessions 575, 577 and 566 shown in red) had an average of 1.8 % bloom at the same date.

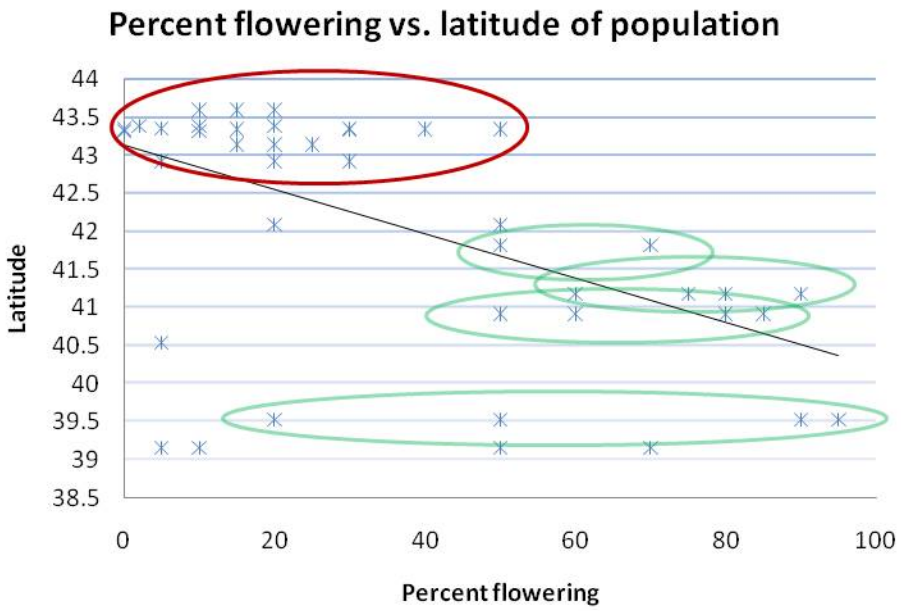


Figure 5. Scatterplot showing percent flowering (x axis) versus latitude of original population (y axis) evaluated on June 14, 2010. Northerly populations (red) had just begun to flower, while most southerly populations (green) were well into their bloom period.

DISCUSSION

Seed processing

To assess Douglas' dustymaiden's potential for commercial seed production, several methods of seed processing were evaluated. Various small-lot seed cleaning machines were tested including a brush dehuller, debearder, gravity table and airscreen cleaner. We found it difficult to remove the membranous pappus from the achene, and complete removal may be unobtainable. This may become problematic when attempting to seed through a range drill or other seeding equipment, especially without the aid of a dilutent such as rice hulls. Good results came from hammer-milling the seed with a sizeable amount of plant material (figure 6). The inert matter appeared to help in rubbing the pappus from the achenes. Using the hammer-mill or debearder without inert material did not provide enough weight or friction for successful achene removal. Some damage occurred to seed during milling, but germination rates of milled seed do not appear to differ significantly from un-milled seed.

An alternate method used by USDA Forest Service at the Bend, OR Seed Extractory is to use a Westrup Model LA-H laboratory brush machine with a #40 mantel at a speed of 3 to dislodge seed from the flower heads and remove the pappus. The gate is left completely open to allow the seed to move quickly through the machine and avoid damaging the achenes. This is followed by air-screening (Barner 2009).

In 2010, we harvested the plots using a vacuum type harvester (Bair and Tilley 2010). Using this machine, it is possible to collect seed of high enough quality that additional processing may not be necessary. Seed harvested in this manner did have an intact pappus and fair to moderate purity; however, when mixed with a dilutent such as rice hulls, the seed flowed well through grain and no-till drills and other seeding equipment.

Figure 6. Clockwise from top left: unprocessed seed shaken directly from plant to avoid excess chaff; unprocessed seed; seed processed with a hammer-mill; a cleaned lot of seed. Photo by Derek Tilley.

Pollinators

Douglas' dustymaiden plants provide pollen and nectar to a variety of insect visitors. Insect surveys at the Aberdeen Plant Materials Center showed visitation by: sweat bees (*Halictus ligatus*), green sweat bees (*Agapostemon* sp.), Hunt's bumblebees (*Bombus huntii*), and mason bees (*Osmia* sp.), and *Micranthophora flexipes* as well as European honey bees (*Apis mellifera*) (figure 7).

Figure 7. Bee pollinators of Douglas' dustymaiden. Left to right: honey bee (*Apis melifera*), green sweat bee (*Agapostemon* sp.), and sweat bee (*Halictus ligatus*). Photos by Derek Tilley.

Managing seed production fields for native bee habitat may improve seed yield. In the spring of 2010, PMC staff attempted to establish a hive of *Osmia californica* near the dustymaiden planting. Bee blocks and bee larvae provided by Jim Cane of the ARS Bee Lab in Logan, Utah were placed next to the planting; however the colony failed to establish, possibly due to predation from magpies as young bees were emerging from their overwintering tubes.

Release Development

Several factors are being considered with regard to release type. Mooring (1980), detected diploid, tetraploid and hexaploid (2n=12, 24 and 36) chromosome counts in Douglas' dustymaiden within the Aberdeen PMC service area. Diploids were more frequent at higher elevations and polyploids inhabited lower elevations or areas of Pleistocene or later disturbance. DNA samples of all the accessions were provided to the ARS Forage and Range Research Laboratory in 2011. However, the samples were lost due to a refrigerator malfunction.

In our plots, we noticed a general trend towards shorter, earlier flowering plants from southerly latitudes and taller, later blooming plants from northern populations (figure 8). Considering the variability in chromosome counts and the significant morphological variability seen in our study, a multiple-origin polycross release might be an option for use throughout the service area. However, the variability observed in height and flowering date between accessions would create difficulties for seed production. For this reason, it was decided to concentrate our release efforts on the top performer of the northerly and southerly ecotypes.

Figure 8. Two tall-late flowering accession plots flanking a short-early flowering accession. Photo by Derek Tilley.

The top performer of the northern types was accession 9076577, which originates in Boise County, Idaho near Arrow Rock and Lucky Peak Reservoirs, approximately 0.5 miles west of the dam on Forest Road 268. The site is a mountain big sagebrush/bitterbrush community in coarse granitic soils at 960 m (3150 ft) elevation. Accession 9076577 was the tallest accession in our evaluation with an average height of 48.9 cm in June, 2010, and had excellent vigor in the second year (2.00).

Two accessions from the southern range performed very well, accession 9076636 from Cache County, Utah, and accession 9076635 from Morgan County, Utah. Accession 9076636 is located in Logan Canyon on Utah Highway 89 at 5,600 ft elevation on an open road cut in a Douglas fir/Rocky Mountain Maple community in association with Idaho fescue, bluebunch wheatgrass and arrowleaf balsamroot.

Accession 9076635 is located in a bitterbrush, rabbitbrush, mountain big sagebrush community at Lost Creek Reservoir on the west side of the dam. The population occurs on coarse soils at 6,000 ft elevation.

In the fall of 2010, the sites for 9076635, 9076636 and 9076577 were revisited to make additional seed collections for increase plantings at the PMC; however, we were unable to find enough seed at the Morgan County and Cache County sites for collection. A single 500 ft row of 9076577 was planted in November of 2010 into weed barrier fabric; however the seed failed to establish. Two additional rows of 9076577 were planted in November 2011, but these plantings were also deemed failures. No further plantings were attempted.

CONCLUSION

Several accession of Douglas' dustymaiden showed promise for a selected class release. Collections from Morgan and Cache County in northern Utah, as well as an accession from Boise County in western Idaho all performed well compared to other accessions. Difficulties in getting adequate establishment for seed production fields were viewed as potential deal breakers for the native seed industry and the project was ended. Aberdeen PMC may visit this species again in the future.

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